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# Waste Reduction in Food Canning Operations

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27 Abstract

Trickling Filter --The effects of hydraulic loading and nutrient addition on soluble B.O.D. removal from fruit waste water were investigated. In 1968, at 1250 gpd/sq ft without nutrient addition, 190 lbs of B.O.D./1000 cu ft/day were removed; with nutrient (anhydrous ammonia) addition, 450 lbs of B.O.D. were removed. At 2200 gpd/sq ft, B.O.D. removal decreased slightly.

pH Control --Fruit pumping water was acidified with citric acid and controlled at pH 4.0 or below to inhibit bacterial growth and to extend the use of recirculated water. The daily discharge volume of acidified system was 6720 gallons containing 118 lbs of B.O.D.; non-acidified, 26,520 gallons, 170 lbs B.O.D.

Air Flotation System -- Removal from peach rinse water was 65 to 93 percent at 2700 gpd/sq ft and 1400 gpd/sq ft respectively. A 70 percent removal was maintained at 2300 gpd/sq ft for peach and 1400 gpd/sq ft for tomato waste water.

Screens --The maximum capacity of the single (20 mesh) deck was 1000 gpm. Compared to 20 mesh rectangular screen, 48 mesh removed 32.2 percent more solids. For the double deck unit containing a 20 mesh top and 100 mesh bottom, the unit handled 1500 gpm - 1.5 times the single deck unit. (Rose - Natl Canners Assn)

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# *Waste Reduction in Food Canning Operations*

A Study of Four Methods To Improve the
Quality or Reduce the Quantity of Effluent Discharged
By a Fruit Processing Plant

by

National Canners Association
Research Foundation
Western Research Laboratory
Berkeley, California 94710

for the

FEDERAL WATER QUALITY ADMINISTRATION
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## ABSTRACT

Trickling Filter - A high rate unit was constructed, utilizing light weight, self-supporting plastic packing medium that provided large uniform surface area for microbial growth. The effects of hydraulic loading and nutrient addition on soluble B.O.D. removal from fruit waste water were investigated. In 1968, at 1250 gpd/sq ft without nutrient addition, 190 lbs of B.O.D. / 1000 cu ft/day were removed; with nutrient (anhydrous ammonia) addition, 450 lbs of B.O.D. were removed. At 2200 gpd/sq ft , B.O.D. removal decreased slightly.

pH Control - Fruit pumping water was acidified with citric acid and controlled at pH 4.0 or below to inhibit bacterial growth and to extend the use of recirculated water. The sanitary condition of the acidified system was equal to or better than a comparable non-acidified system. The daily discharge volume of acidified system was 6720 gallons containing 118 lbs of B.O.D.; non-acidifed, 26,520 gallons, 170 lbs B.O.D.

Air Flotation System - This system was evaluated for suspended solids removal efficiency. The influent to recycle ratio was 1:1. Removal efficiency decreased as the hydraulic rate increased. Removal from peach rinse water was 65 percent to 93 percent at 2700 gpd/sq ft and 1400 gpd/sq ft respectively. A 70 percent removal was maintained at 2300 gpd/sq ft for peach and 1400 gpd/sq ft for tomato; the difference was attributed to large quantities of dirt in the tomato waste water.

Screens- A single deck and a double deck circular vibrating screen were evaluated for solids separation. The maximum capacity of the single (20 mesh) deck was 1000 gpm. With a 64 mesh, capacity was reduced to 300 - 400 gpm. Compared to 20 mesh rectangular screen, 48 mesh removed 32.2 percent more solids. For the double deck, numerous combinations of top and bottom screens were tested. With a 20 mesh top and 100 mesh bottom, the unit handled 1500 gpm - 1.5 times the single deck unit. More than 5 percent of influent must overflow from top screen onto bottom screen; otherwise abrasive action of screen will increase solids in effluent.



This report was submitted in fulfillment of Grant No. WPRD - 151 - 01 - 68 between the Federal Water Pollution Control Administration and the National Canners Association.

Key Words: Trickling filters, disinfection, separation techniques, screens, canneries, industrial wastes.

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## SECTION I

## CONCLUSIONS

### High-Rate Trickling Filter

Fruit processing waste waters are low in nitrogen which is necessary for successful biological treatment.

With equal hydraulic loadings of 0.88 gpm/ sq ft, 190 lbs B.O.D./1000 cu ft/day were removed without nitrogen addition. With anhydrous ammonia 450 lbs B.O.D./1000 cu ft/day were removed.

Without nitrogen addition, a heavy fungal growth established on the packing medium, resulting in objectionable odors.

The percent B.O.D. removal significantly decreased as the hydraulic rate increased. The pounds of B.O.D. removed at increased hydraulic loadings was not as seriously affected.

### pH Control of Recirculated Flume Water

A 75 percent water savings can be achieved by the acid system as compared to a non-acidified flume system.

The acidified system discharges 30 percent less B.O.D. than the control system.

Water temperature is elevated with increased recirculation.

Control of the pH at 4.0 or below can inhibit bacterial growth even at the higher water temperatures.

Low bacterial population can be maintained for a least 24 hours in an acidified system.

### Air Flotation for Removal of Suspended Solids

Over 70 percent of the suspended solids from peach rinse water can be removed by the unit at a hydraulic loading of 3.2 gpm/sq ft and an influent-recycle ratio of 1:1.

At 1.0 gpm/sq ft the removal efficiency is greater than 90 percent for peach rinse water.

For influent-recycle ratios less than one the removal efficiency decreased.

The percent suspended solids removal for tomato waste water was less than for peach rinse water.

Center Discharge Screening for Liquid and Solids Separation

Single deck circular vibrating screens have twice the hydraulic capacity of table top screens of comparable mesh size and area.

Two deck circular vibrating screens have 1.5 times the hydraulic capacity of single deck circular vibrating screens.

The effluent from a 48 mesh circular screen contains 32 percent less suspended solids than the conventional 20 mesh table top screen.

With a two deck unit, a minimum of 5 percent of the influent must be discharged to the bottom screen to reduce the abrasive action of the screen on the solid waste.

## SECTION II

## RECOMMENDATIONS

### High-Rate Trickling Filter

Collect additional performance data to develop cost factors and to evaluate the influence of other environmental parameters, such as pH control on B.O.D. removals.

Determine B.O.D. removals at various media packing depths.

### pH Control of Recirculated Flume Water

Develop a means of foam control and removal of large particulate solids from the recirculated water.

### Air Flotation for Removal of Suspended Solids

Investigate the use of polyelectrolytes or coagulant aids in improving the removal of suspended solids.

Remove the pit fragments from peach rinse water in order to operate the unit without recycle pressurization.

### Center Discharge Screening for Liquid and Solids Separation

The removal of heavy or jagged objects from the influent before screening should be implemented to reduce damage to fine mesh screens.

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## SECTION III

## INTRODUCTION

Within recent years, dramatic technological advances in the preparation and canning of foods have greatly changed the physical and chemical nature of liquid waste streams. Production of canned foods have more than doubled in the last 25 years. In the face of predictions of famine immediately ahead and continued population growth, this production and preservation of foods must continue to accerlerate. At the same time, intensified efforts must be made to find technologically-effective and economically-feasible solutions to the waste disposal problems of the food processing industry.

To produce the canning industry's annual nationwide pack of 760 million cases of canned foods, more than 36 billion gallons of water is required. Although much of this volume of water is reclaimed from previous uses, the industry is entirely dependent on the availability of water of good quality. Because of food quality improvements and more rigid definitions of cleanliness, it must be expected that water used and reused in food processing will increase. Today, raw foods must be thoroughly washed to remove toxic chemical residues as well as natural contaminants present on field-grown crops.

If the 36 billion gallons of clean water taken in by the canning industry were discharged after use, without treatment, the pollution potential would be equal to more than 300 billion gallons of domestic sewage. Fortunately, much of this liquid waste is treated in cannery-operated or city-operated treatment plants.

The major differences in the nature of cannery wastes from that of other wastes must be recognized. In comparison with domestic sewage, food processing wastes are much higher in pollutional strength. Of the total organic load, 70 to 85 percent is present in the dissolved form. Depending on the food being canned, the waste waters may carry sugars, starches, and fruit acids in solution. These dissolved solids are not removed by mechanical or physical separation methods. Stabilization of the dissolved components may be accomplished by oxidation and/or adsorption.

The four phase program, initiated in 1967, was planned as a preliminary step in designing larger-scale experimentation treatment of food processing wastes. Objectives of the project were as follows:

To develop information on the effectiveness of treating strong liquid wastes with a high-rate trickling filter.

To evaluate under cannery conditions the effects of controlling, by the addition of edible acids, the sanitary condition of waters recirculated in product pumping and fluming systems, and to determine if the total organic waste load discharged from the systems is decreased as a result of reduced leaching of product juices.

To determine the effectiveness of air-flotation systems for removing suspended solids as a means of reducing pollution potentials of liquid waste streams from food canning operations.

To evaluate the performance of center-discharge, fine-screen separators in removing suspended solids from cannery waste streams.

To select, on the basis of results obtained, a system or systems to be enlarged in scale and to be operated during a second year of study.

## SECTION IV

## HIGH RATE TRICKLING FILTER TREATMENT OF LIQUID WASTE

The purpose of this phase of the project was to evaluate the performance of an intermediate size trickling filter filled with plastic packing medium in reducing the pollutional load of liquid wastes from fruit canning.

The scope of the evaluation included a determination of maximum B.O.D. removal, under varying B.O.D. and hydraulic loading.

Outlined below are variables investigated in 1967 and 1968 to provide the necessary information for a technological evaluation of trickling filter efficiency in treating low volume - high strength waste waters.

Variation of hydraulic loading: Equal ratio of fresh and recycled waste water were incrementally increased in volume to determine the maximum hydraulic load that could be effectively treated.

Nutrient addition: Nitrogen was added to determine its effect on microbial growth and B.O.D. reduction.

Organic loading: For each of the parameters listed above, the organic loading was calculated. The applied organic load and the organic load discharged were used to measure the efficiency of the filter.

A schematic diagram of the major components of the trickling filter system is shown in Figure 1. More detailed information about the trickling filter system is shown in the Appendix. The Engineering Section of Del Monte Corporation was instrumental in the design, construction and installation of the treatment system.

In physical dimensions, the treatment column was a tank 12 feet in diameter and 29 feet in height. It was packed to a height of 21.5 feet with plastic medium resulting in a filter volume of 2410 cubic feet and a cross-sectional area of 113 square feet. At the height of 21.5 feet the packing medium was self-supporting and did not require the use of an intermediate support dock.

The wet-well sump consisted of a round tank 5 feet 8 inches in diameter and 10 feet in depth. Approximately 8 feet of tank was placed below ground level to permit a gravity flow from the treatment column to one section of the sump. A baffle, extending to within 6 inches of the bottom, divided the sump into two equal sections. In one section of the sump a low level control was

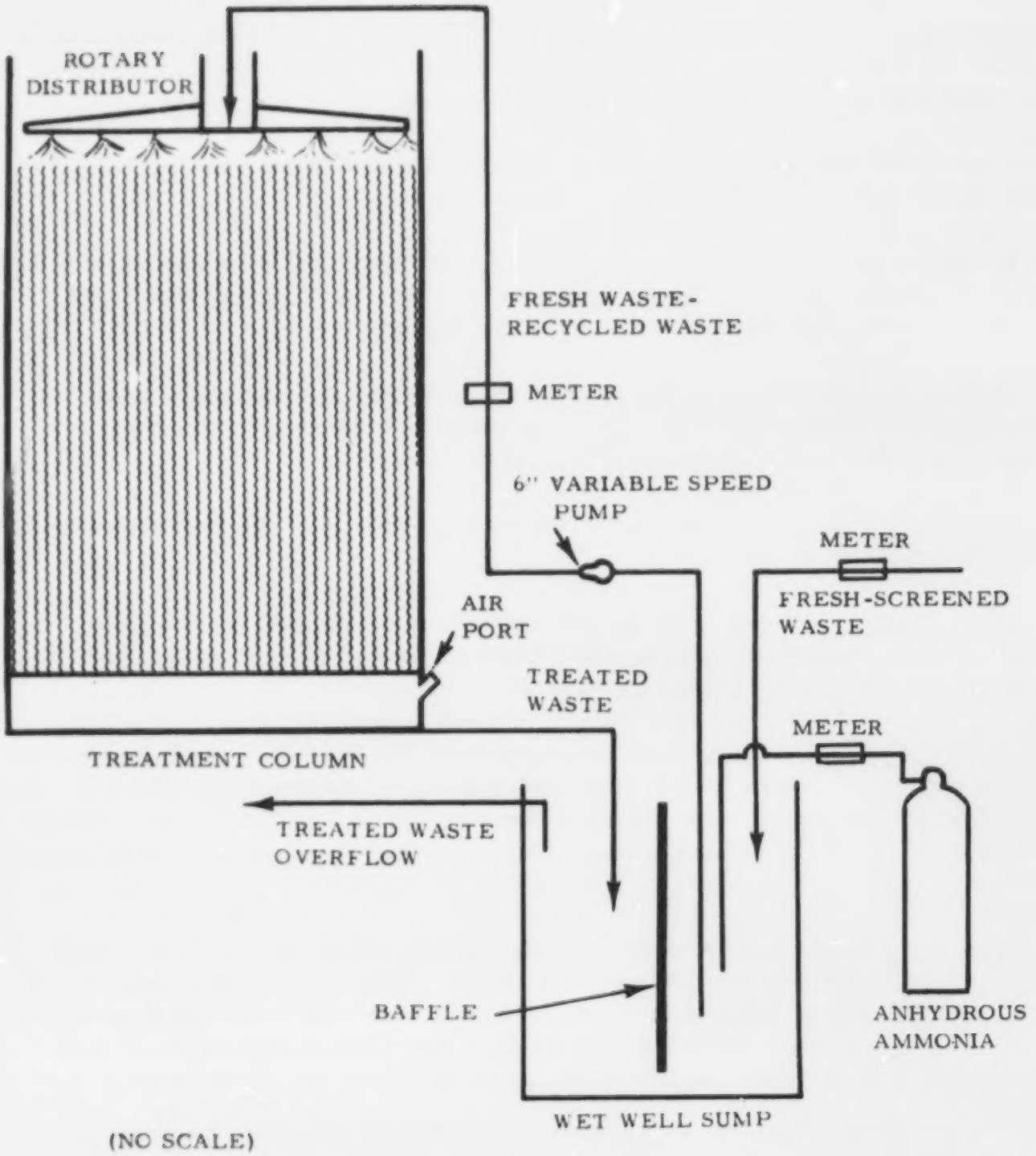


Figure 1. High rate trickling filter system.

placed to prevent the pump from running dry. Figure 2 is a photograph of the tricking filter system.

The plastic medium was shipped from Midland, Michigan to Oakland, California as expanded bundles. Figure 3 is a photograph of a bundle. The trickling filter medium was made from polyvinyl chloride, first vacuum formed into corrugated sheets, then welded into the honey comb designed bundle. This configuration gave the medium a high void (94 percent) and a large surface area (27 sq ft/cu ft) for microbial slime growth. Figs. 4, 5, 6, and 7 provide more photographic details of the trickling filter system.

To permit a natural up-draft of air through the treatment column, air ports were installed around the base of the tank. Four-inch pipe sections were welded to the tank at 40 degree intervals to give a total of 9 ports. Prior to the start of the 1968 canning season, additional ports were added to the treatment column to give a total of 18 ports.

The fresh waste to be treated by the trickling filter system was a portion of the plant composite waste flow which had been screened by a 20-mesh vibrating screen. Peaches and fruit cocktail were being canned during the time that the filter was in operation.

A variable speed pump withdrew the liquid from the sump and delivered the liquid to the top of the filter. There a mechanically-driven rotary distributor spread the liquid evenly over the surface of the packing medium. The distribution arms rotated at 2 RPM. The distributor contained four V-shaped troughs with notches spaced to evenly spread the liquid over the surface of the packing medium. The liquid, after passing down through the filter, collected at the bottom and was returned to the second section of the wet-well sump. The excess partially treated waste overflowed out of the sump.

The volume of liquid delivered to the treatment column by the variable speed pump was always greater than the amount of fresh waste entering the sump. The difference between the total volume pumped and the fresh waste entering constituted the recycled volume. For example, if 100 gpm fresh waste entered the first section of the wet-well and a total volume of 200 gpm was pumped to the trickling filter then the ratio of fresh to recycle was 1:1.

The filter was placed into operation July 27, 1968. The raw waste feed rate was 40 gpm with 100 gpm of recycle. After 4 days at this rate, sufficient microbial slime had developed on the packing medium to consider the unit operational. On July 31, 1968, the fresh waste feed rate was increased to 75 gpm with 75 gpm recycle. On August 10, 1968, the fresh and recycle rates

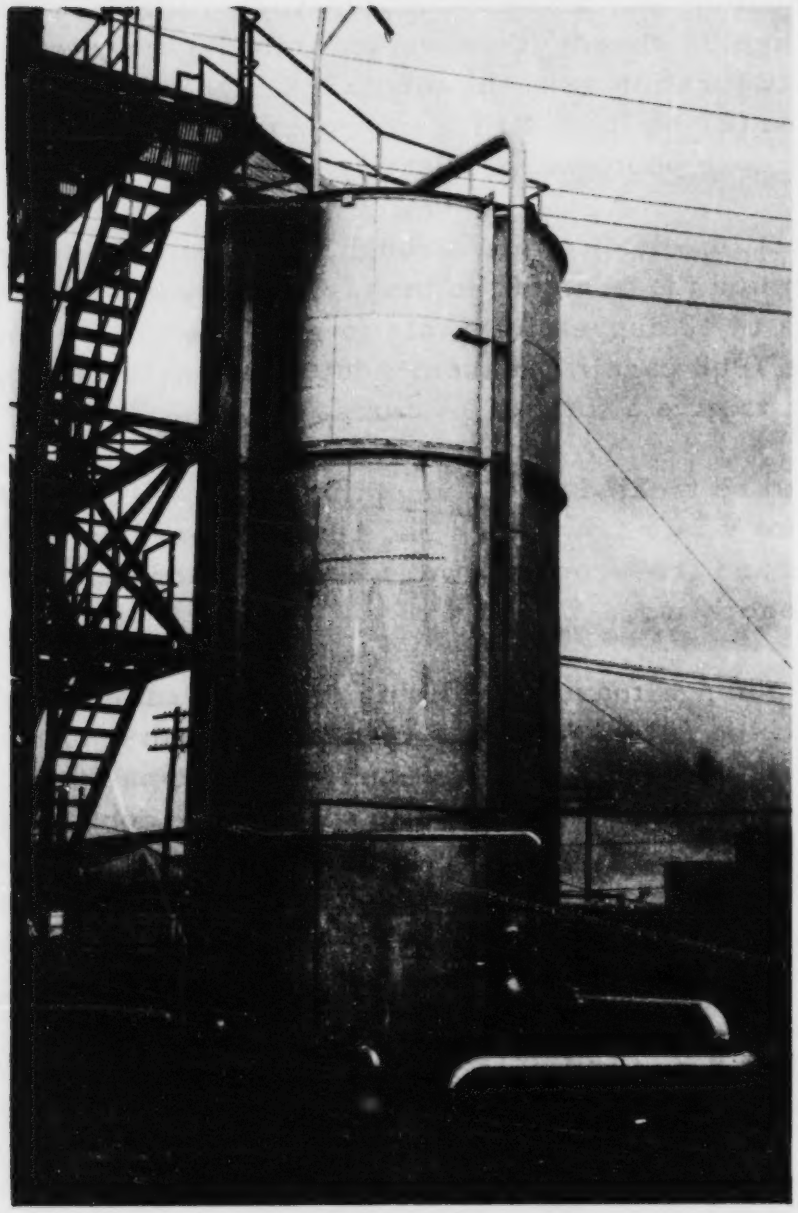

Figure 2. Overall view of the trickling filter system.

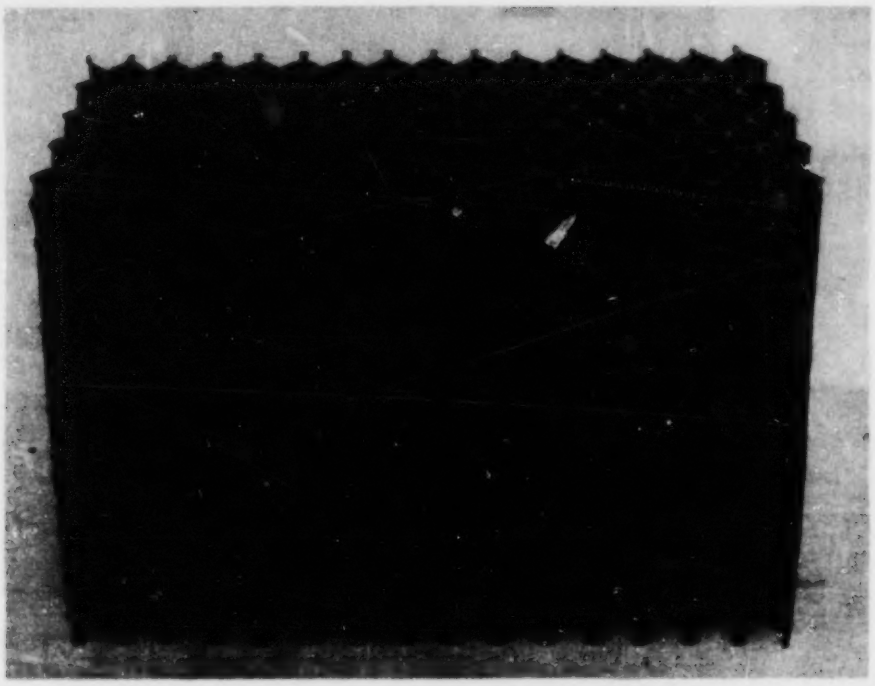

Figure 3. Single bundle of packing medium.

Figure 4. Cutting of packing medium.

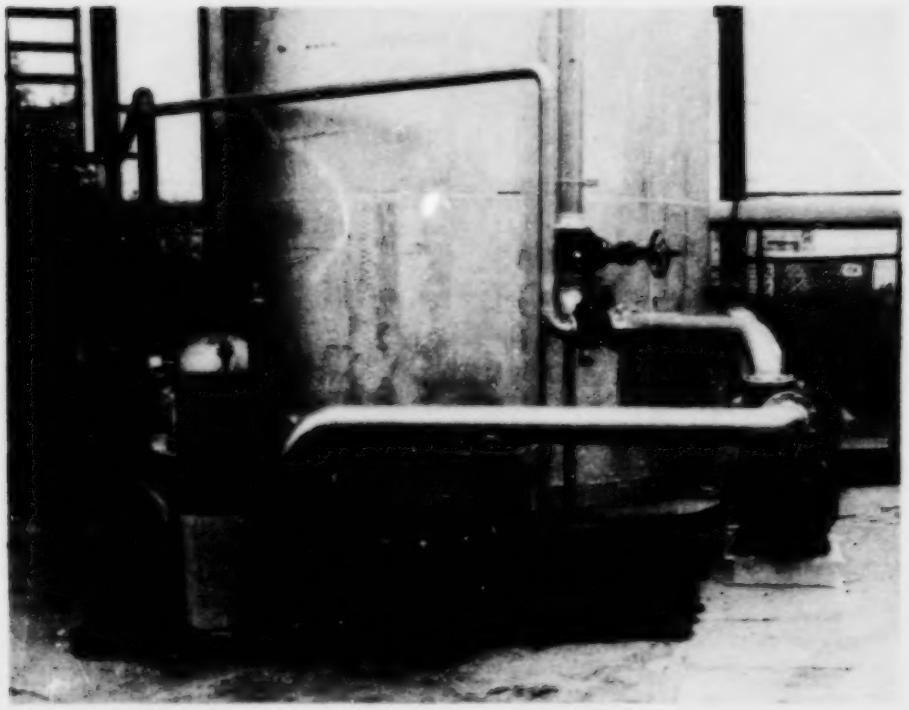

Figure 5. Base of trickling filter.

Figure 6. Top view of trickling filter.

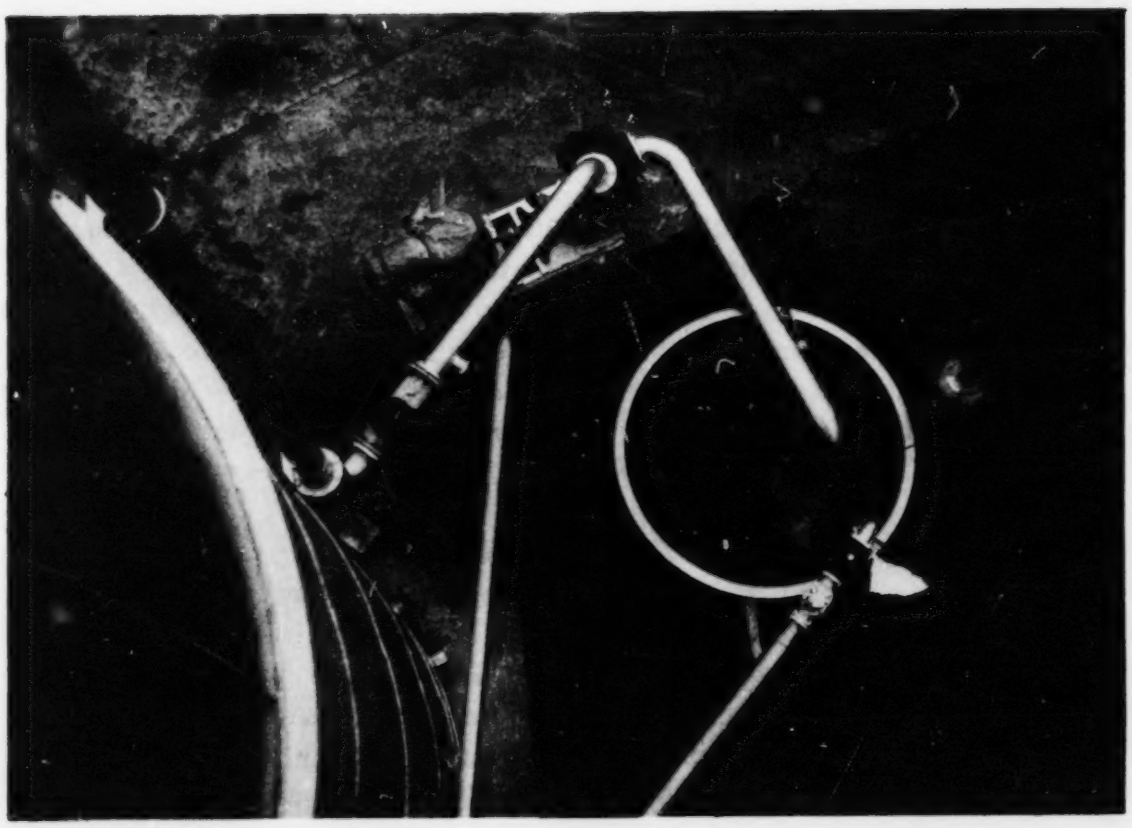

Figure 7. View from top of treatment column.

were changed to 100 gpm for each stream. On August 22, 1968, anhydrous ammonia was introduced into the fresh waste section of the wet-well sump. Ammonia was added to give a nitrogen to B.O.D. removal ratio of 1:20. The nitrogen calculation was based on a 50 percent B.O.D. removal by the filter. On September 3, 1968, the rates were increased again to 175 gpm fresh and 100 gpm recycle. This rate continued until the end of the season which was September 14, 1968. The flow meter, used to measure the gaseous anhydrous ammonia, was calibrated by obtaining weight losses at various float meter settings.

Soon after the filter became operational, it was noted that a heavy slime growth had developed on the packing medium. This growth did not easily slough from the filter and eventually gave rise to the production of objectionable odors. Microscopic examination of the slime revealed that its composition was predominantly fungal and not bacterial growth. The slime growth was so thick that anaerobic conditions existed which probably were responsible for the odors. Air could not diffuse through the slime growth to maintain aerobic conditions.

Beginning with the addition of anhydrous ammonia on August 22, 1968, the characteristics of the slime on the packing medium rapidly changed. The heavy fungal slime growth sloughed from the filter within two days and was replaced by a thin, transparent slime. This slime was composed mainly of bacteria. It was also noted that this type of slime growth continuously sloughed from the filter and gave the appearance of an activated sludge floc. Tests showed that the floc rapidly settled when placed in Imhoff cones.

For each day of operation, samples of approximately one quart in volume were collected of the influent and effluent. These samples were taken at four-hour intervals or more frequently and held under refrigeration. At the end of the sampling day, which lasted up to 16 hours, two composite samples were made from the individual samples. One composite sample was filtered through cotton or glass wool and used for the B.O.D. determination. The other composite was used for the suspended solids determination. The composite samples, after proper identification, were then frozen in milk cartons and remained frozen until an analysis was made at the Berkeley Laboratory. Each day that samples were collected, readings of the two meters were also taken and adjustments made to maintain rates.

The following analyses was performed on the samples of influent and effluent:

| | |
|---|---|
| chemical oxygen demand | suspended solids |
| biochemical oxygen demand | pH |

Table 1 is a summary of the percent reduction in C.O.D. and pounds of C.O.D. removed per 1000 cubic feet of packing medium at the three fresh-waste feed rates from experiments in 1967. As shown in the table, the pounds removed increased with an increase in the hydraulic load delivered to the tower. Time was not available for a determination of the maximum loading that could be handled by the filter. No adjustment in the pH of the fresh waste was made during the evaluation. The incoming waste had a pH of 9.0 to 9.5, while the treated effluent was near 6.5 to 7.0.

TABLE I

SUMMARY OF OPERATIONAL DATA - 1967

| Flow (gpm) | | Chemical Oxygen Demand (ppm) | | C.O.D. Removed per 1000 cu ft/day | |
|---|---|---|---|---|---|
| Fresh | Recycle | In | Out | (lbs) | Reduction |
| 50 | 150 | 2300 | 1300 | 310 | 44 |
| 100 | 100 | 2300 | 1100 | 550 | 52 |
| 150 | 150 | 3400 | 2200 | 900 | 35 |

Table 2 is a summary of the data collected during the 1968 season. The data collected on a daily basis is presented in the Appendix.

TABLE II

SUMMARY OF OPERATIONAL DATA - 1968

| Period of Operation | Hydraulic Load Gal./Min/sq ft | Organic Load Lbs B.O.D./1000 cu ft / day | Organic Removal Lbs B.O.D./1000 cu ft / day | Percent Removal |
|---|---|---|---|---|
| 8/1 - 8/9 | 0.66 | 640 | 340 | 53 |
| 8/13 - 8/21 | 0.88 | 950 | 190 | 20 |
| 8/22 - 8/31 | 0.88 * | 1160 | 450 | 39 |
| 9/4 - 9/14 | 1.54 * | 1550 | 400 | 26 |

*Ammonia Added

Liquid waste from the processing of fruit products is very low in nitrogen. Analysis indicates that approximately 10 ppm total nitrogen may be present in such waste waters. For biological treatment, available nitrogen is required for microbial growth. To effectively remove carbohydrate and other non-protein compounds from the waste water by a biological system it is necessary to add 5 ppm nitrogen for every 100 ppm B.O.D. removed.

Without a nitrogen addition to the trickling filter systems it was noted that a heavy slime growth developed on the packing medium. Microscopic examination of the slime revealed a dense fungal mass with some bacteria present. With time the slime growth increased in thickness before shearing from the packing medium. During this period of operation objectionable odors were detected coming from the top of the trickling filter.

As indicated in Table II, there was a decrease in the performance of the trickling filter during the second week of operation without nutrient addition. The B.O.D. removed from the system decreased from 340 to 190 lbs/day/1000 cu ft. The percent B.O.D. removal during this period also decreased from 53 to 20.

Following 3 weeks of operation in 1968 without nutrient addition, anhydrous ammonia was added to the waste water. The heavy slime layer quickly sloughed from the packing medium and was replaced by a thin bacterial slime. The results indicated a marked improvement in the performance of the trickling filter. At a hydraulic loading of 0.88 gpm/sq ft, with anhydrous ammonia added, there was an increase in the lbs of B.O.D/1000 cu ft/day removed. The increased removal was from 190 to 450 and the percent B.O.D. removal was from 20 to 39.

When operating with ammonia, the effluent contained floc particles, giving it the appearance of an activated sludge effluent before clarification. Without nitrogen addition, the effluent would frequently contain large masses of insoluble material. The heavy slime growth would intermittently shear from the plastic packing medium while the thin bacterial slime continuously sloughed.

## SECTION V

## pH CONTROL OF RECIRCULATED FRUIT FLUMING WATERS

The purpose of this phase of the project was to confirm on a commercial scale the results found earlier in laboratory experiments that control of pH did inhibit bacterial growth in fruit pumping waters and made long term use possible without sacrifice of sanitary conditions. The scope of the experiments included the determination of the quantity of citric acid required to maintain pH of 4.0, bacterial counts on representative samples, and determination of B.O.D. and temperature.

Figure 8 is a schematic drawing of the pH control system. In this system, cling peach halves, after final sorting and inspection, were discharged into water and pumped to the can filler. The peaches were de-watered and the water returned to the surge tank. Fresh water could be added to the system to provide dilution. Adjacent to the system was a similar system which served as the control. For both systems, water meters were installed to measure the amount of fresh water added.

Initially, problems were encountered in attempting to control the pH of the acidified flume system. It was not possible to continually pass a sample of liquid through the pH sensor without it becoming plugged by small fruit particles. The placing of a strainer in the line helped, but did not completely eliminate the problem. The final solution was the development of an all-plastic electrode that could be placed directly into the surge tank without fear of breakage. By placing the electrode directly into the water, the need for a sensor was eliminated and better pH control of the water was achieved.

There was a tendency for foaming to occur in the surge tank as the soluble solids built up in the recirculated water. This was controlled by installing fan-type sprays in such a manner that the water discharged almost parallel to the surface of foam. Fine mist overhead sprays were not satisfactory in breaking the foam bubbles.

When very little make-up water was being added to the acidified system, there was a gradual accumulation of small fruit particles. A separation device such as a screen is needed to remove this fruit, otherwise it may be carried out of the water with the product.

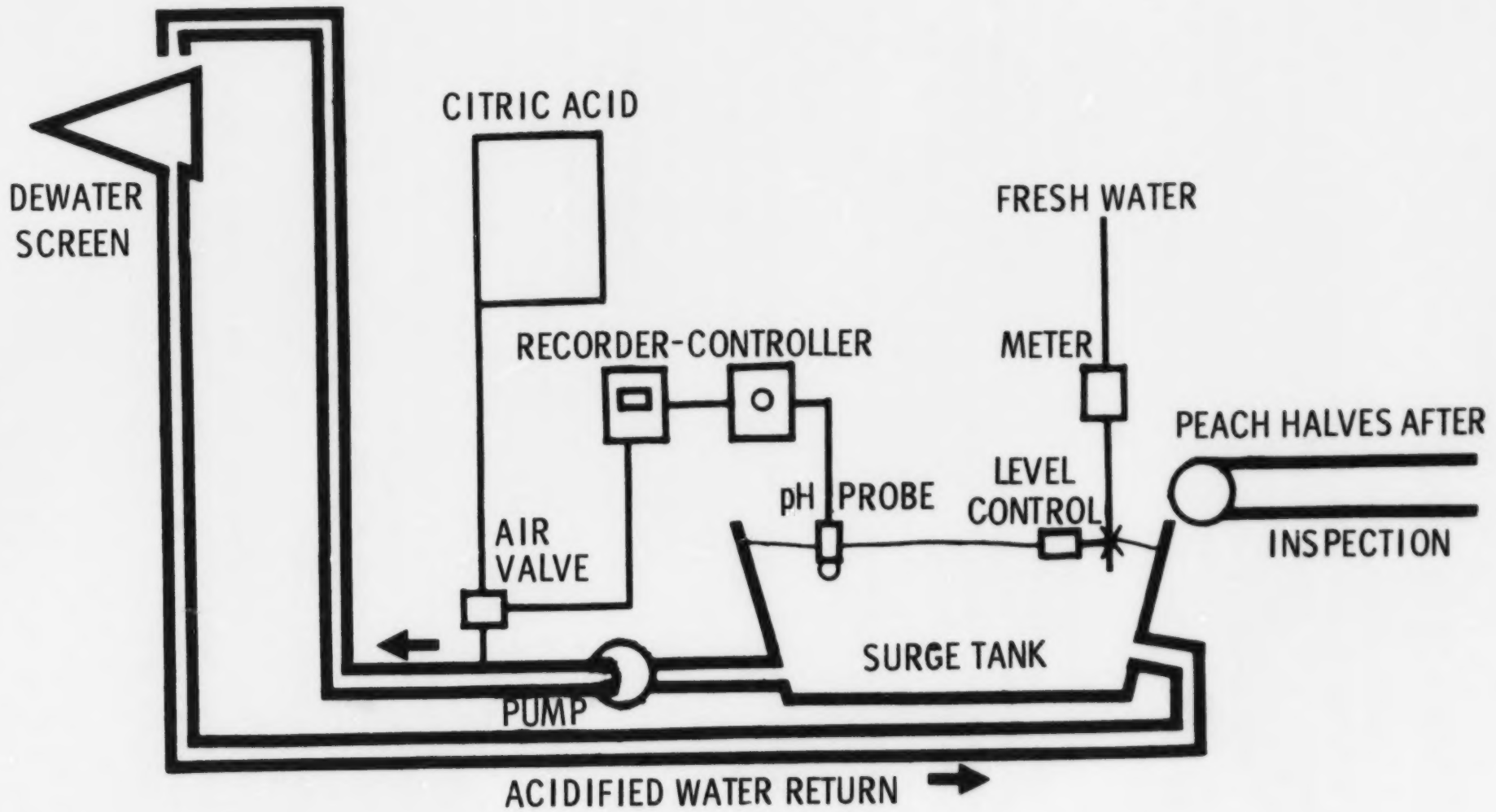


Figure 8. pH control system.

Generally, the control flume operated at a make-up rate of 20 gpm. As shown in the results, the pH was near neutrality. Laboratory results showed this pH was most favorable for bacterial growth and high bacterial counts were found in the water even though considerable fresh water was added. At 20 gpm fresh water addition, sufficient water was added every 6 minutes to equal a complete change of water in the system.

Grab samples were collected at two hour intervals. For the bacteriological counts, the samples were collected in sterile test tubes and held under refrigeration until the following day. The samples were then diluted in sterile water blanks, plated on glucose-tryptone agar and incubated for 2 days at 86°F. After incubation the plates were counted and recorded as total plate count.

Temperature, pH, water meter readings, titratable acidity and citric acid consumption were recorded at the plant. One quart samples were collected in milk cartons and held under refrigeration until analyzed for B.O.D.

Each day four cans of the final product were collected from the acidified and non-acidified systems. These cans were held until the end of the season, then compared for differences in quality.

Shown in Table III are typical results of tests performed on samples collected from the two water recirculation systems. The relative bacterial count shown in this table was obtained by reducing the total plate count to a common denominator. Additional results are given in the Appendix. Results are given for a 24-hour day on samples taken at 2-hour intervals. Almost without exception, the bacterial count for the acidified system was equal to or lower than the control flume.

Shown in Table IV is the amount of fresh water make-up added to each system. The acidified system in this case was using only 25 percent of the amount of fresh water used in the control system.

TABLE III

pH CONTROL OF FRUIT PUMPING WATER

| Time of Sampling | Relative Bacterial Count | | pH | | Temp °F | |
|---|---|---|---|---|---|---|
| | Test System | Cont. System | Test System | Cont. System | Test System | Cont. System |
| 6 a.m. | 0.5 | 6 | 4.4 | 7.6 | 67 | 67 |
| 8 a.m. | 63 | 138 | 4.1 | 7.2 | 72 | 70 |
| 10 a.m. | 72 | 226 | 3.9 | 7.3 | 75 | 72 |
| 12 noon | 39 | 106 | 3.8 | 7.4 | 72 | 70 |
| 2 p.m. | 84 | 137 | 3.9 | 7.4 | 74 | 70 |
| 4 p.m. | 61 | 111 | 4.0 | 7.4 | 76 | 72 |
| 6 p.m. | 97 | 60 | 3.9 | 7.7 | 76 | 70 |
| 8 p.m. | 41 | 82 | 3.8 | 7.4 | 75 | 71 |
| 10 p.m. | 67 | 80 | 3.9 | 7.2 | 76 | 72 |
| 12 midnight | 13 | 22 | 3.8 | 7.5 | 75 | 69 |
| 2 a.m. | 2 | 59 | 3.8 | 7.4 | 74 | 69 |
| 4 a.m. | 17 | 9 | 3.8 | 7.3 | 75 | 71 |

TABLE IV

CHARACTERISTICS OF FRUIT PUMPING WATER

(24 hours of operation)

| Measurement | Acidified | Control |
|---|---|---|
| Water Make-Up, GPM | 5 | 20 |
| Total Water Volume Used, Gallons | 6,720 | 26,520 |
| Average B.O.D., ppm | 2,034 | 742 |
| Total B.O.D. Discharged, Pounds | 118 | 170 |

Table V is a summary of the quantity of citric acid used in relation to the volume of water added to the system. The values reported in Table V are averages of several days of operation.

TABLE V

CITRIC ACID CONSUMPTION AT VARIOUS FRESH WATER FLOW RATES

| Flow in gallons per hour | Lbs citric acid added per hour |
|---|---|
| 65 | 2.1 |
| 160 | 2.3 |
| 220 | 2.4 |
| 330 | 2.8 |
| 420 | 3.1 |
| 560 | 3.2 |
| 700 | 3.6 |

One of the most significant savings in using a pH control system is in the reduced quantity of water required to maintain the sanitary condition of the recirculated water system. The acidified system was operated at a make-up rate equal to 25 percent of the control system. The two principle benefits from using less water are: a reduction in the quantity of fresh water and a reduction in the volume of effluent. Using the current water charges in San Jose, the reduced intake of fresh water would pay for the citric acid used in controlling the pH of the water. A water savings of 20,000 gallons per day reduces the water bill by $6.00. Using an average of 2.5 pounds of citric acid per hour and 10 cents per pound, the cost of the acid is equal to the savings in the smaller volume of

water used. There would be a net savings in sewer service charges for the reduction in the volume of effluent and lbs of BOD discharged.

The pH control system was operated continuously for only 24 hour periods. It is very possible that even longer periods of operation could have been used and the rate of fresh water reduced. This would have resulted in even greater savings in water, citric acid and fewer pounds of B.O.D. being discharged.

Results have shown that microbial multiplication can be controlled in an acid system. Still, it is important that in using such a system, care must be taken to insure that the system does not contain dead ends or blind spots which would be favorable places for microbial growth.

## SECTION VI

## AIR FLOTATION FOR REMOVAL OF SUSPENDED SOLIDS

If waste water supersaturated with air and under pressure is suddenly released into an open tank at atmospheric pressure, the volume of air contained above saturation comes out of solution in the form of fine bubbles. These adhere to particles of suspended matter in the liquid and carry the particles to the surface, forming a layer of "float" that can be removed by a skimming mechanism.

The purpose of this study was to determine the range in suspended solids removal by the pressure air flotation system for various hydraulic loadings. Two waste streams were selected for this evaluation. One was the rinse water after exposure of peaches to a caustic solution and the other was the screened effluent from tomato processing.

Figure 9 is a schematic drawing of the air flotation unit. The inner chamber of the flotation cell contains 10 square feet of surface area and this number is used in calculating the solids loading. The outer chamber contains 15.4 square feet and this number is used in calculating the hydraulic loading. The process consists of four operations as follows:

Pressurization - As stated before, the liquid waste must be pressurized. This is accomplished by a two-stage pumping system. The first-stage pump transfers the liquid from the effluent system of the cannery to the second-stage pump. Between the first and second stage, air is injected into the liquid stream.

As this mixture enters the second pump, two processes occur simultaneously:

The gas-liquid is subjected to a high shear-force created by the revolving pump impellers. This creates a high degree of turbulence which greatly enhances the gas-liquid transfer that must occur for efficient flotation operation.

The pressure on the liquid is built up to the desired operating level.

Dissolution - Since the gas-liquid transfer is a rate function, a tank, specially designed for the application, is provided. This, in effect, provides more time for the transfer to occur.

Flotation - The pressurized gas-laden liquid is fed into the flotator. The pressure is released and the air comes out of solution in the form of very fine bubbles. The bubbles attach themselves to the solids which in turn rise to the liquid surface and are removed mechanically by a rotating float collector

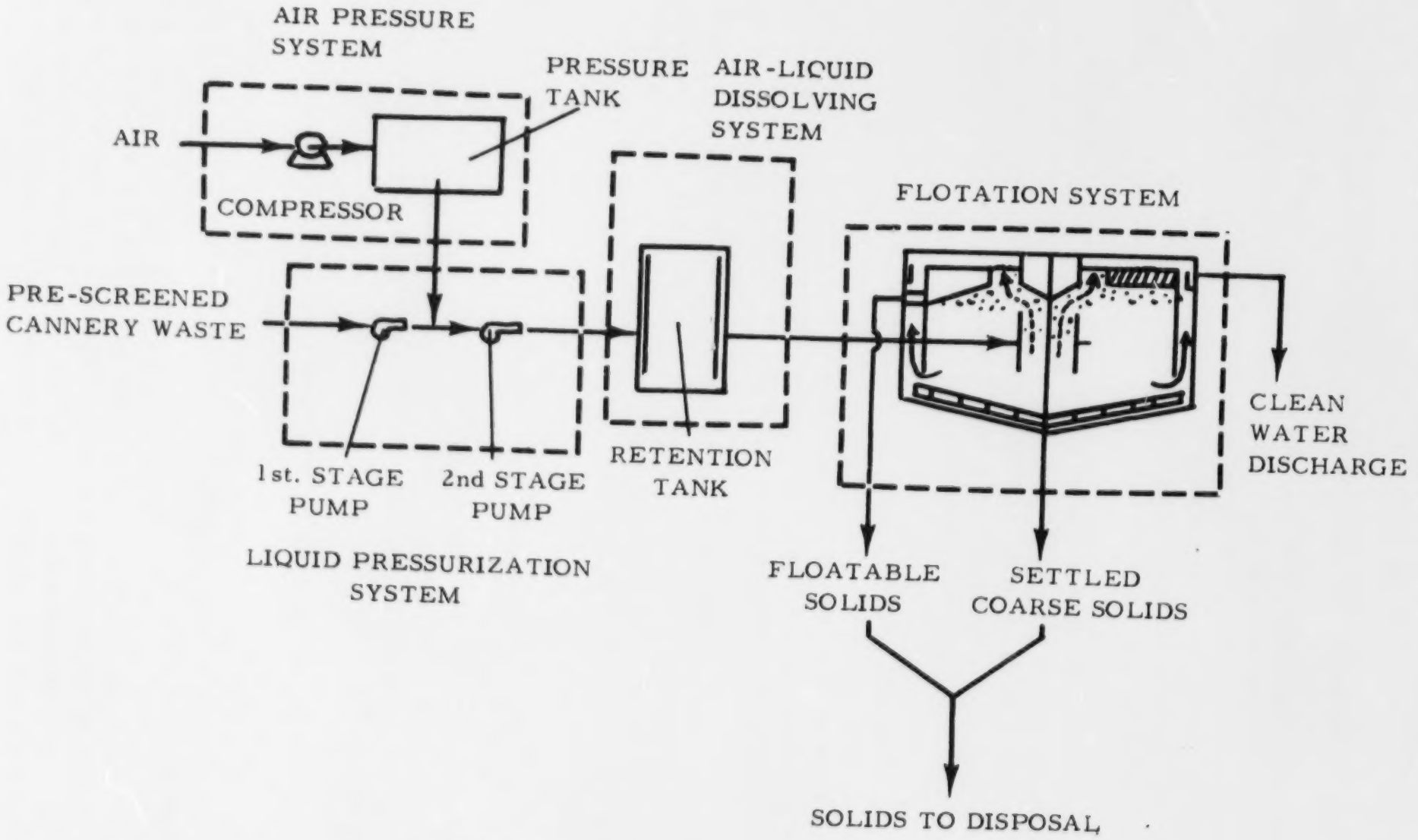


Figure 9. Air flotation system.

that discharges into a float box.

The clarified water flows to a collection launder around the periphery of the tank. This water is sufficiently low in suspended solids to be directly discharged into the municipal sewer system.

If any coarse solids by-pass the pre-screening system, they are collected in the bottom of the tank. A rotating scraper assembly moves these settled solids to a central discharge point where the solids can be collected and combined with the float solids for final disposal.

Air Compression - This system merely supplies a quantity of compressed air for dissolution in the liquid to be treated.

Photographic details of the pilot scale air flotation unit are shown in Figures 10 - 13. A 55 gallon drum was placed on top of the flotation cell to act as a surge tank. Two 55 gallon drums were placed on either side of the flotation cell to collect the float material. Another 55 gallon drum was used to measure the volume of clarified effluent from the unit.

The air flotation unit was originally set up to pressurize the influent. For the peach rinse water it was determined that this method of operation was not possible. The rinse water was used to convey peach pits from the plant. After separation the water contained pit fragments and fruit particles which prevented an accurate measurement of the flow. Therefore, the unit was re-piped so that the effluent passed through the pressurization system then mixed with the rinse water just prior to being introduced into the flotation cell.

Hour grab samples were collected of the influent, effluent and float. At the end of 4 hours a composite was made of the grab samples. The analysis was performed on the composite samples. At the end of 4 or 8 hours of operation, the quantity of float material in the 55 gallon drums was determined. The flow of effluent into the third 55 gallon drum was determined by using a stop watch and measuring the time required to fill a given volume.

Figure 14 is a bar graph of the results obtained when peach rinse water served as the influent. The performance of the unit was influenced by the total hydraulic load and the relationships between the quantity of fresh and recycle flows. The percent of suspended solids removed from the influent decreased as the flow increased. At 7.5 gpm the removal was 93% and at 30 gpm it was 65 percent.

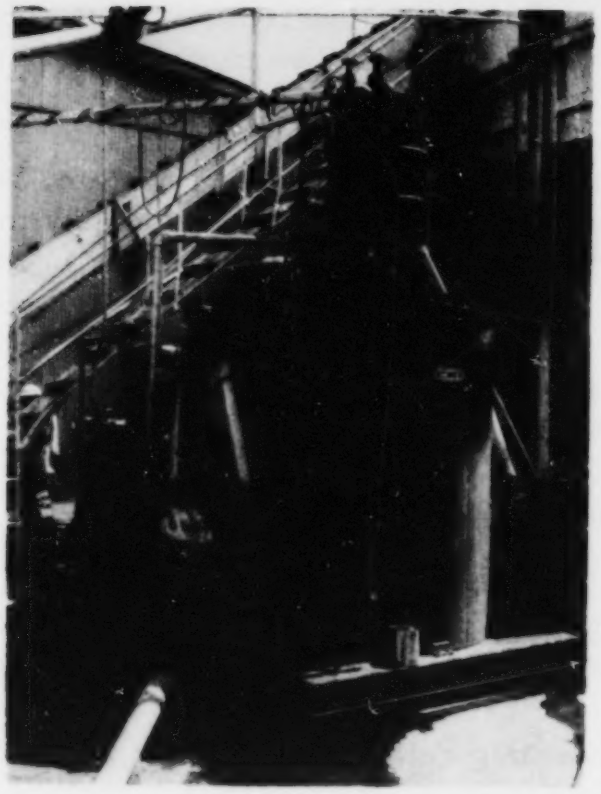

Figure 10. Front view of pilot scale air flotation unit.

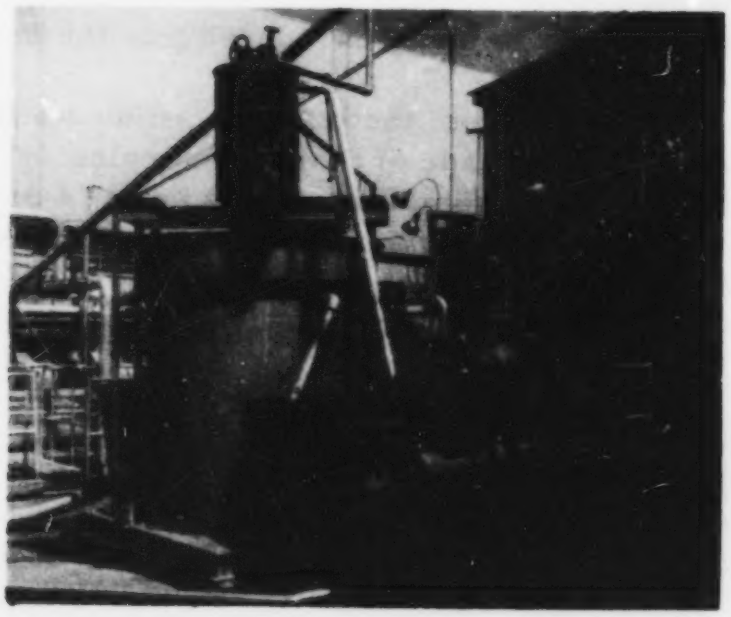

Figure 11. Rear view of air flotation unit.

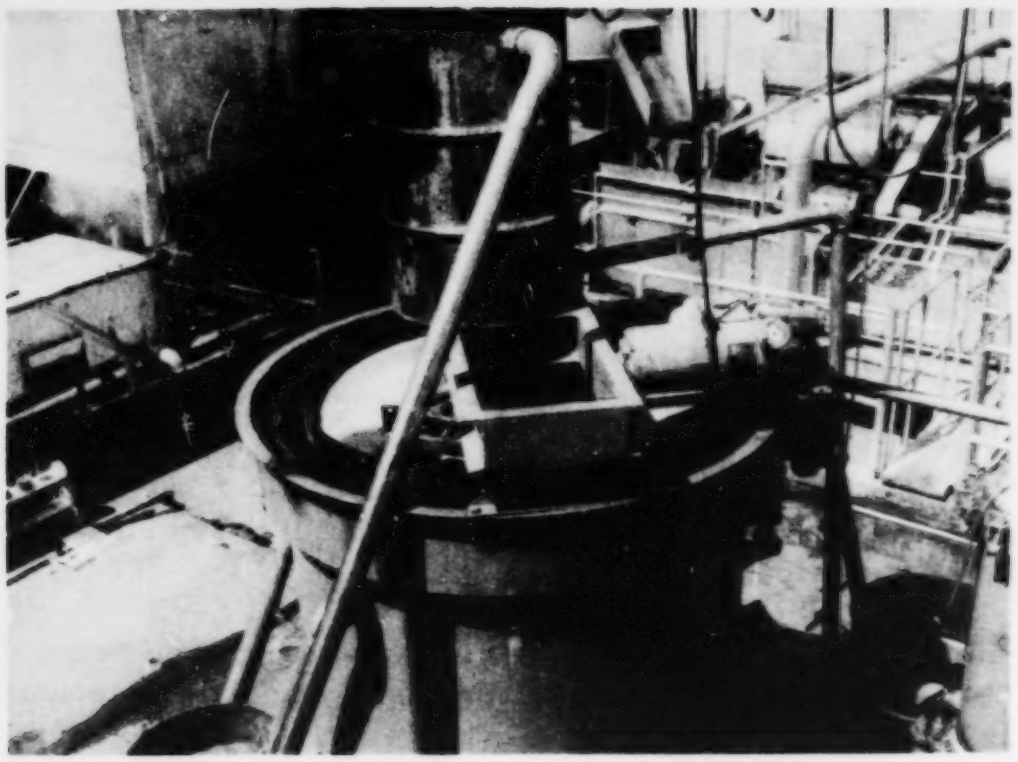

Figure 12. Top view of flotation cell.

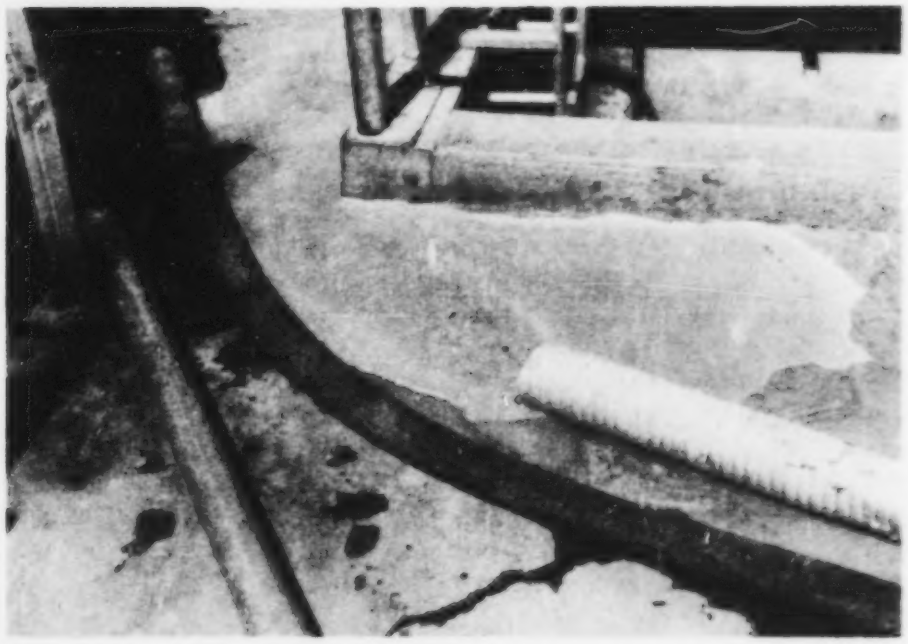

Figure 13. Discharge of collected float material.

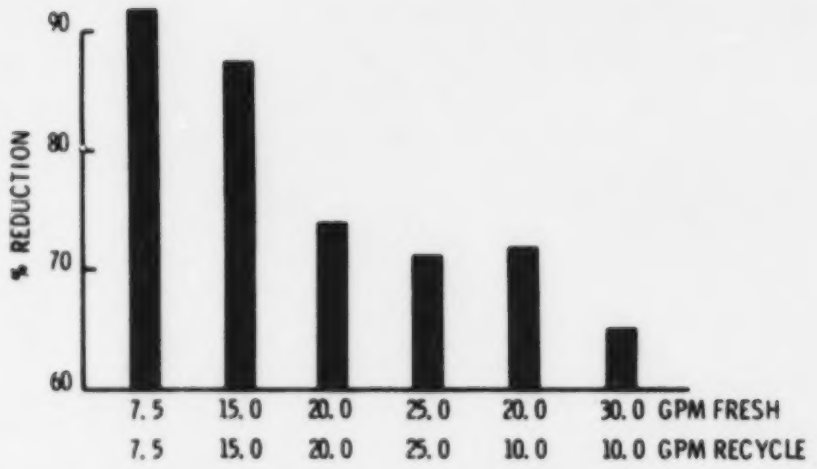


Figure 14.. Reduction in suspended solids content of peach rinse water by air flotation.

Tabulated in Table VI are averages for the data collected on peach rinse water. The individual analyses of the composite samples are contained in Appendix D.

In general the volume of float material removed from the flotation cell increased with an increase in the total hydraulic load. The concentration of suspended solids in the float generally decreased as the hydraulic rate increased.

TABLE VI

AVERAGE VALUES FOR REMOVAL BY AIR-FLOTATION OF SUSPENDED SOLIDS FROM PEACH RINSE WATER

| Influent Raw (gpm) | Influent Recycle (gpm) | Hydraulic Loading ($gpm/ft^2$) | Influent Solids (ppm) | Effluent Solids (ppm) | Percent Removal | Float Vol. (gph) | Float Solids (%w/v) | Solids Loading ($lbs/hr/ft^2$) |
|---|---|---|---|---|---|---|---|---|
| 7.5 | 7.5 | 1.0 | 1400 | 90 | 93.2 | 3.6 | 2.1 | 0.6 |
| 15.0 | 15.0 | 1.9 | 1500 | 180 | 87.7 | 3.6 | 1.7 | 0.7 |
| 20.0 | 20.0 | 2.6 | 1300 | 340 | 74.0 | 7.8 | 1.5 | 1.2 |
| 25.0 | 25.0 | 3.2 | 700 | 190 | 71.0 | 7.8 | 1.3 | 0.8 |
| 20.0 | 10.0 | 1.9 | 900 | 230 | 72.0 | 6.7 | 2.0 | 0.9 |
| 30.0 | 15.0 | 2.9 | 1500 | 590 | 66.1 | 7.8 | 1.6 | 2.2 |
| 30.0 | 10.0 | 2.6 | 200 | 70 | 64.8 | 2.3 | 2.1 | 0.3 |

Table VII presents the data collected when the air flotation unit operated with tomato waste water. The waste water had passed through a 20 mesh vibrating screen prior to being pumped to the flotation unit.

The percent removals are slightly less than those obtained for the peach rinse water. The principle difference between the results for the two types of waste waters is the higher solids content in the tomato float material, the reduced volume of float collected and the lower solids loadings.

TABLE VII

AVERAGE VALUES FOR REMOVAL BY AIR-FLOTATION OF SUSPENDED SOLIDS FROM TOMATO WASTE WATER

| Influent Raw Recycle (gpm) | | Hydraulic Loading ($gpm/ft^2$) | Influent Solids (ppm) | Effluent Solids (ppm) | Percent Removal | Float (gph) | Float (%w/v) | Solids Loading ($lbs/day/ft^2$) |
|---|---|---|---|---|---|---|---|---|
| 7.5 | 7.5 | 1.0 | 1100 | 180 | 83.5 | 6.5 | 8.3 | 9.7 |
| 15.0 | 15.0 | 1.9 | 1100 | 240 | 77.7 | 11.1 | 3.0 | 19.5 |
| 30.0 | 15.0 | 2.9 | 500 | 180 | 60.7 | 8.8 | 3.1 | 15.9 |

Figures 15 and 16 illustrate the principle difference observed in the float collected from the two types of waste waters. When placed in Imhoff cones, the peach float always separated into 3 fractions. Most of the float went to the top of the cone, with some settling to the bottom.

For the tomato float, there was very little free liquid and also only a small amount of settleable material in the Imhoff cones. The tomatoes had been machine harvested and upon delivery to the cannery contained large amounts of field soil. The air flotation unit removed most of the soil which probably contributed to the high solids content of the tomato float material.

The peach rinse water contained pit fragments and fruit particles which prevented the direct pressurization of the waste flow. It was necessary to pressurize and recycle a portion of effluent and this reduced the hydraulic capacity of the unit in being able to treat the influent waste stream.

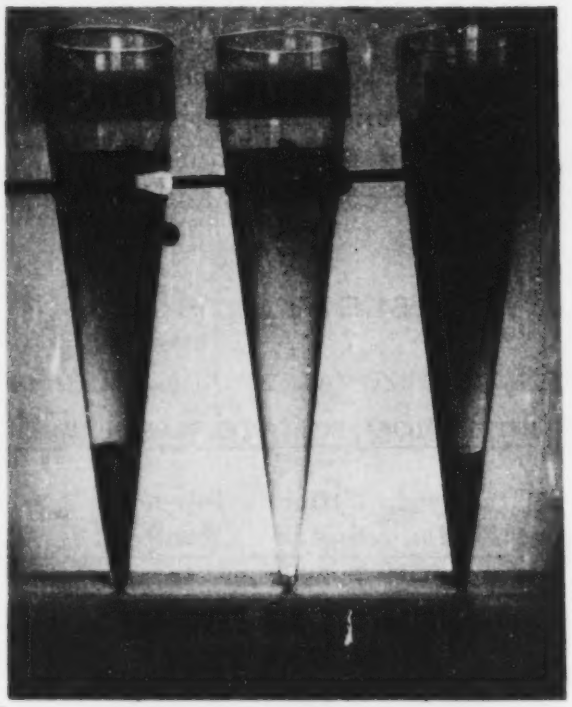

Figure 15. Settleable solids - peach rinse water.

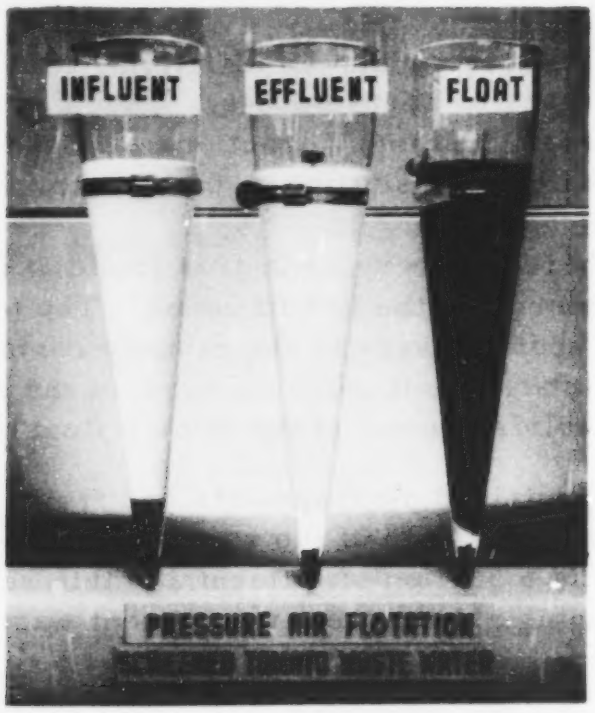


Figure 16. Settleable solids - tomato rinse water.

Suspended solids removal is clearly influenced both by the total hydraulic load and the ratio of raw influent to pressurized flow. Suspended solids removal decreases as the hydraulic flow increases and the ratio of raw influent to pressurized flow increases. For a total hydraulic load of 1.9 gpm per square foot, the suspended solids reduction was 88 percent for a 1:1 ratio; for a 2:1 ratio the percent reduction was 72. Similar results were obtained at a total hydraulic load of 2.6 gpm per square foot and ratios of 1:1, 2:1 and 3:1.

The maximum hydraulic loading which was investigated was 3.2 gpm per sq ft. At this loading over 70 percent of the suspended solids were removed from the peach rinse water. At lower loadings, greater removals were obtained if the ratio of waste to recycle ratio was maintained at one.

The hydraulic rates investigated for tomato waste water were not as extensive as for the peach rinse water. However for those ranges studied, the removals were comparable, being slightly less. At 0.98, 1.95, and 2.92 gpm per sq ft and with comparable ratios of waste to recycle, the percent removals for peach rinse water were 93, 88, and 66. For tomato waste water the percent removals were 84, 78 and 61 percent.

Other than the natural differences between the suspended solids of each of the two waste streams, the tomato waste water contained considerable amounts of soil which may have contributed to the performance of the air flotation system. This soil was the result of the plant receiving machine harvested tomatoes that contained free field soil and dirt adhering to the surface of the product.

The presence of soil in the waste water probably increased the solids content of the collected float material. This seems to be quite evident when the unit was operating at a rate of 0.97 gpm per sq ft in which the solids concentration was 8.3 percent. Under the same conditions, the solids content of float for peach rinse water was 2.1 percent.

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## SECTION VII

## CENTER DISCHARGE VIBRATING SCREENS FOR SEPARATION OF SOLIDS FROM LIQUID WASTE WATERS

The purpose of this project was to evaluate the performance of center-discharge separators in removing suspended solids from cannery liquid waste streams.

The performance of a center-discharge separator, equipped with two screening decks rather than one, was evaluated in 1968 for hydraulic capacity and for effectiveness in removal of solids. Combinations of screens of various mesh sizes were placed on the unit for evaluation. Determinations consisted of waste water in-put volumes and suspended solids content of the effluent for the different combination of screens.

A schematic illustration of the single deck separator is shown in Figure 17. The circular unit was 5 feet in diameter and contained 9 square feet of screening area. In this screening system, solids are forced towards the center for discharge. Beneath the screen a layer of plastic rings vibrate and rotate when the unit is in operation. Use of the rings made possible the screening of large volumes of water and limited blinding problems.

Figure 17. Diagram of single deck center-discharge separator.

Figure 18 is a photograph of a screen used by the single deck separator. At the bottom of the screen are several of the plastic rings. These rings are located on the underneath side of the screen and vibrate against the surface to lessen blinding problems and to permit a greater volume of flow through the screen mesh openings. Figure 19 is a top view of the single deck screen. Four arms distribute waste over the surface of the

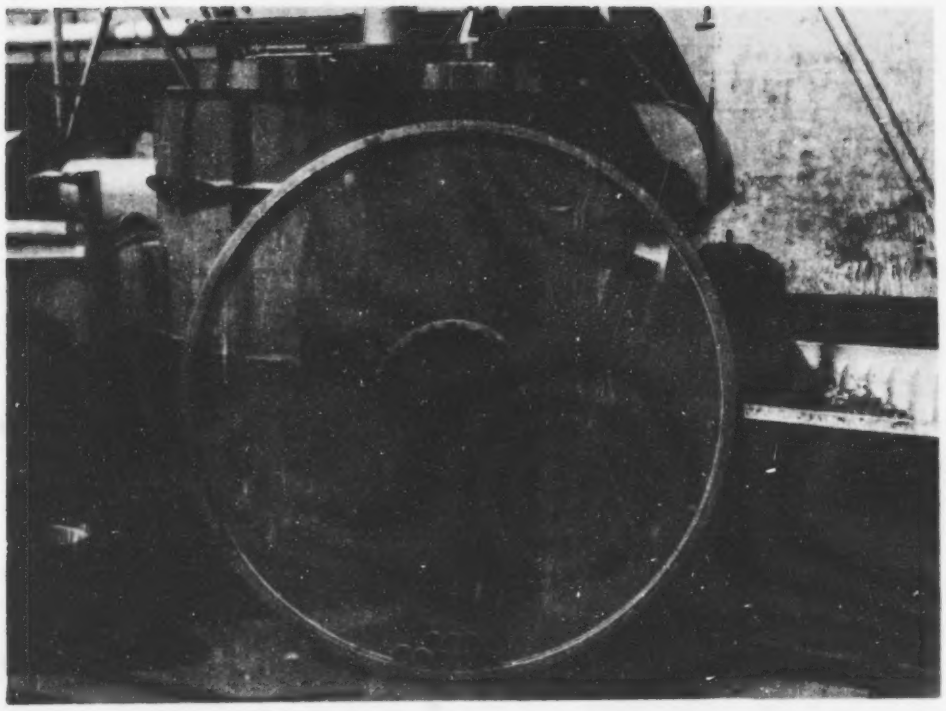

Figure 18. View of circular screen with plastic rings.

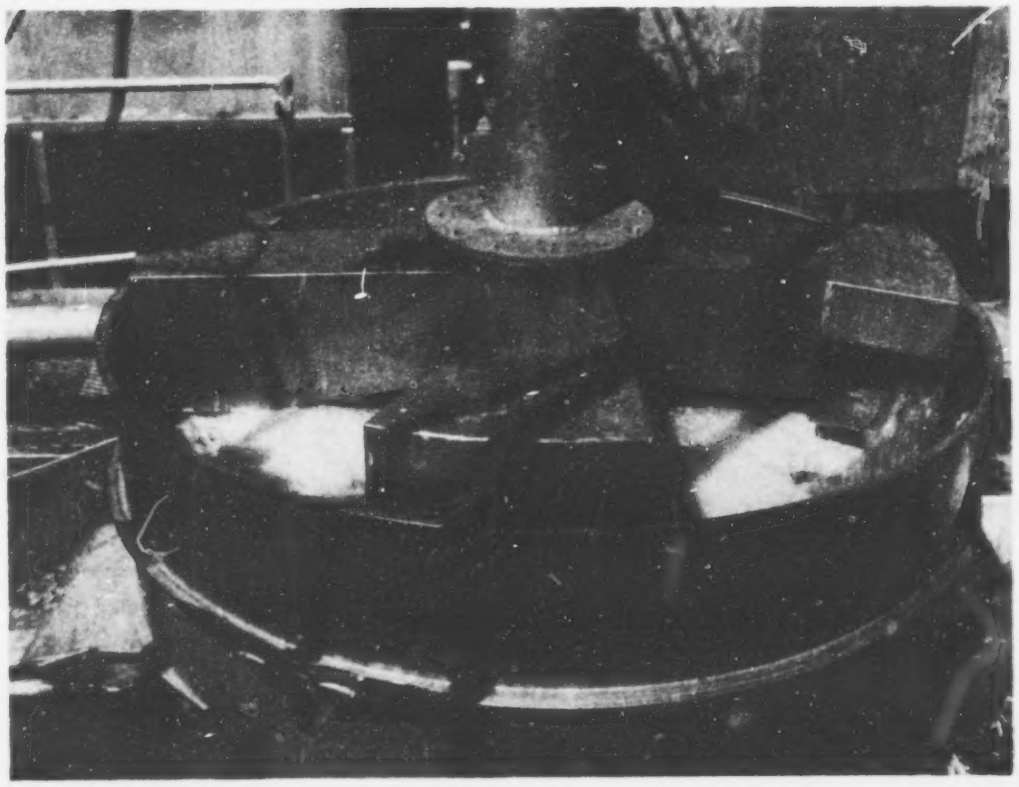

Figure 19. Top view of single deck center discharge separator.

screen. Figure 20 is a close-up view of the separator. The ring or dam of solid wastes is visible around the discharge circle of the screen.

Figure 20. Close-up view of separator.

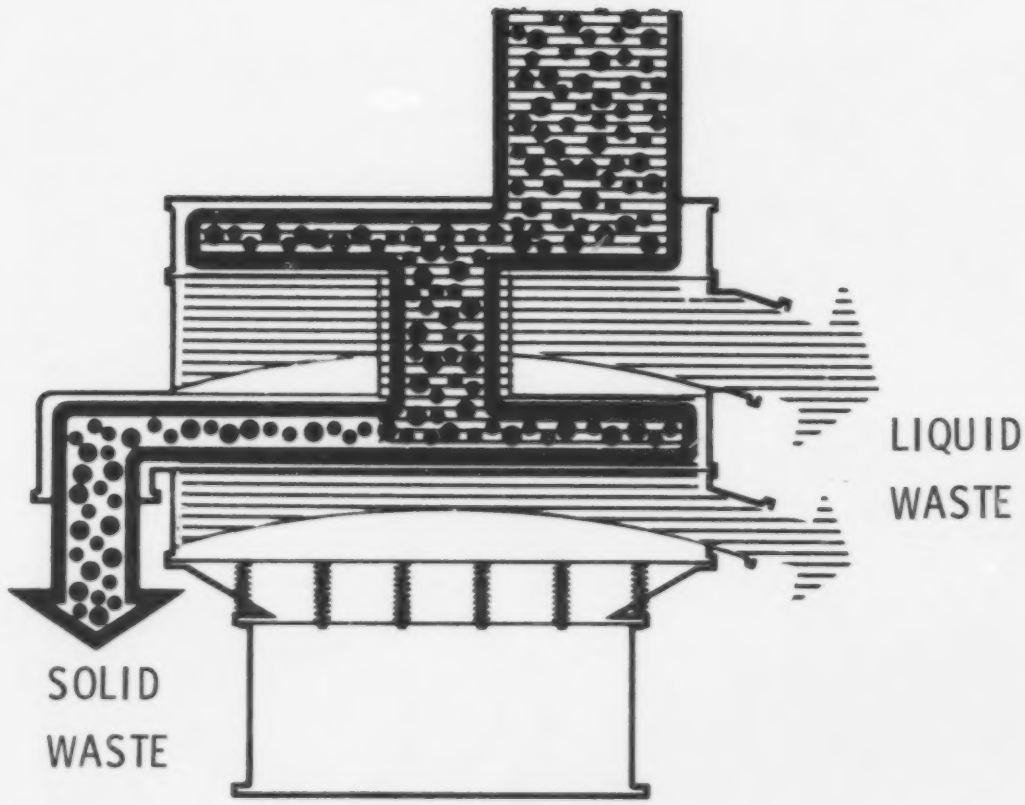


Figure 21. Two deck center discharge separator.

The illustration above (Figure 21) shows how the two-deck center discharge separator works. Flow to the unit is handled through a four-arm feeder that distributes water and solids to the outer periphery of the top screen. The liquid flow pushes the solids to a large center opening in this screen. Solids then fall to the lower screen deck and move to the outer periphery with final discharge out the solids spout.

At the same time, the liquid normally goes through the top screen and is discharged out the water spout located under the top screen. If there is an overflow surge of liquid contained in the material falling through the top screens center opening, the liquid goes through the bottom screen and out the lower water spout. Each circular screen is 60 inches in diameter. The unit is powered by a 2 1/2 horse power motor and weighs approximately 1000 pounds.

Figure 22 is a photograph of the two screens used in a two deck separator. The screen on the left is the top screen and the one on the right is the bottom screen. Figure 23 is a view looking down onto the top of the unit. To the left is located the two spouts that discharge the liquid water. Directly opposite is the spout that discharges the solids.

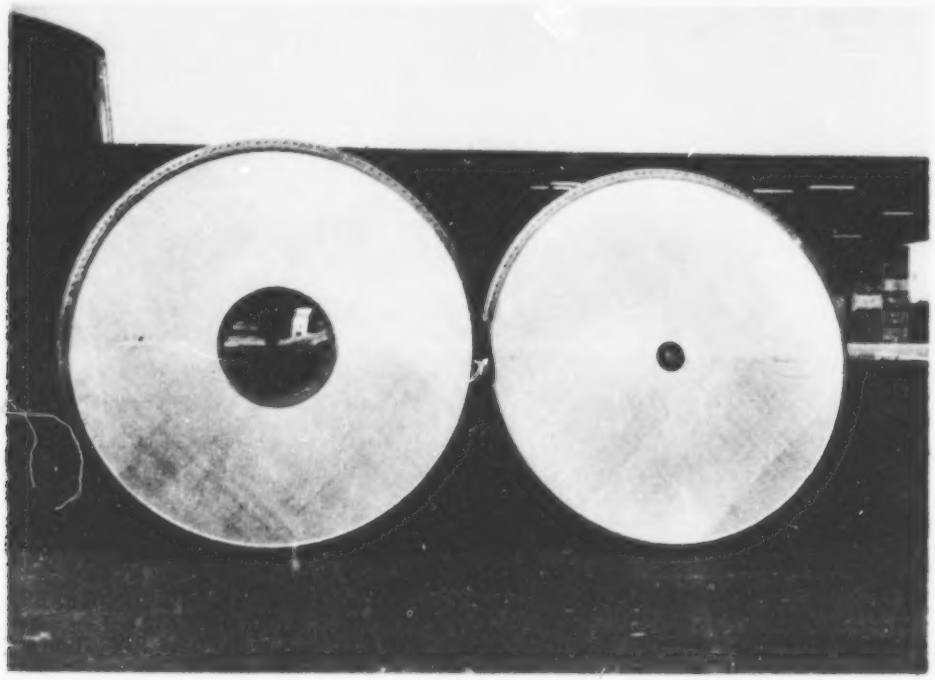

Figure 22. Top and bottom screens for a two deck separator.

Figure 23. Top view of two-deck separator.

Figure 24 is a side view of the two deck separator. Visible is the chute which carried away the solids. On the opposite side is the discharge of the liquid waste water. Figure 25 is a close-up of the solids being discharged from the bottom screen of the two unit deck unit.

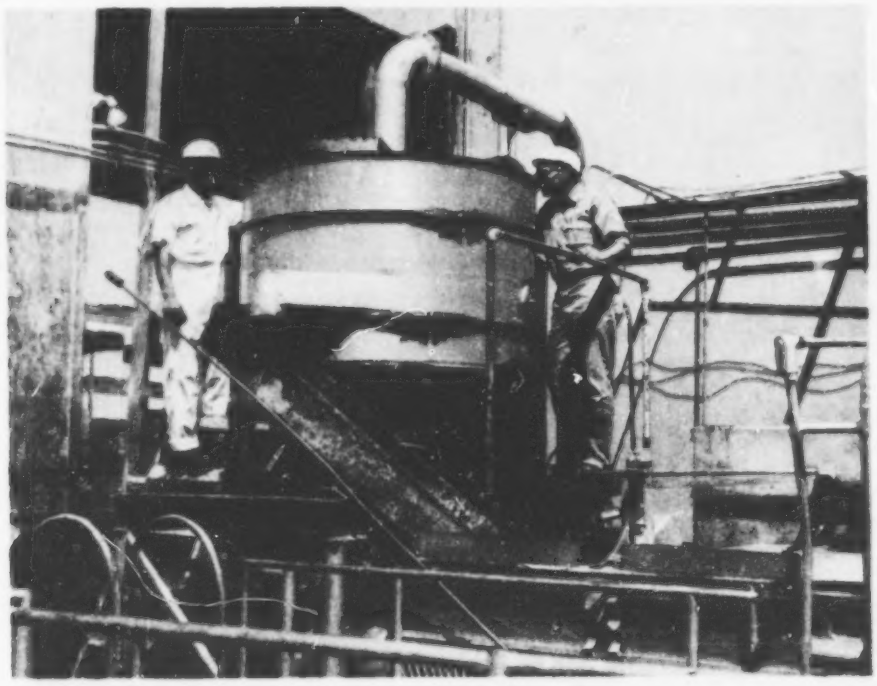

Figure 24. Side view of two deck separator.

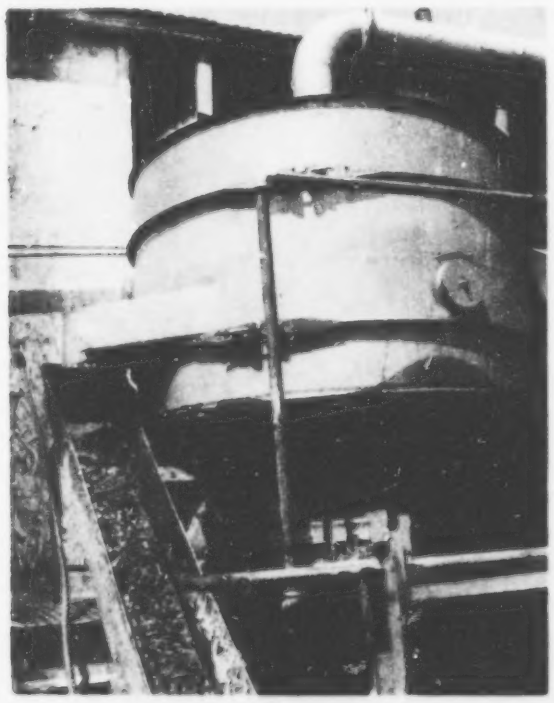

Figure 25. Close-up view of solids discharge.

In evaluating the performance of circular screens, two different grades of screens were used. Some screens were made from wire of a standard diameter commercially used in the manufacture of flat vibrating screens and are referred to as market grade. The other screens were made from wire of a finer diameter and are referred to as tensile bolting cloth screens.

Table VIII provides information about the important characteristics of the two types of screens. For a given mesh rating, the tensile bolting cloth has a greater distance between the wires, resulting in more open area. Since there was a greater percentage of open area on the tensile bolting cloth screens, it was possible to put through a greater volume of waste water as compared to the market grade screens.

The use of finer wire in making tensile bolting screens does mean that precautions should be taken to eliminate from the waste water any sharp metal or heavy objects. In conducting the test program, several screens were damaged because crushed cans, metal and other objects were pumped up onto the screen surface.

TABLE VIII

CHARACTERISTICS OF DIFFERENT SCREEN MESH WIRES

Market Grade

| Mesh | Opening - Inches | Wire Diameter | % of Open Area |
|---|---|---|---|
| 20 | .0340 | .0162 | 46.2 |
| 40 | .0150 | .0104 | 36.0 |
| 48 | ----- | ----- | ---- |
| 64 | ----- | ----- | ---- |
| 78 | ----- | ----- | ---- |
| 80 | .0070 | .0055 | 31.4 |
| 94 | ----- | ----- | ---- |
| 100 | .0055 | .0045 | 30.3 |

Tensile Bolting Cloth

| | | | |
|---|---|---|---|
| 20 | .0410 | .0090 | 67.2 |
| 40 | .0185 | .0065 | 54.8 |
| 48 | .0153 | .0055 | 54.2 |
| 64 | .0111 | .0045 | 50.7 |
| 78 | .0091 | .0037 | 50.6 |
| 80 | .0088 | .0037 | 49.6 |
| 94 | .0071 | .0035 | 45.0 |

In 1967 an evaluation was made to determine the performance of a single deck vibrating screen in removing solids from waste water. Screens of a given mesh size were operated for approximately one week before changing to another mesh size. Samples of influent, effluent and solids were collected at hourly intervals and composited into 4 hour samples for analysis. The flow and the type of solids in the waste water was recorded. Samples were also collected from a 4 ft x 8 ft rectangular 20 mesh screen. The results from the two types of screens were used for comparative purposes.

In 1968 a two deck screen was operated at the same location as was used for the single deck screen. The same operating procedures were used in evaluating the two deck unit. Samples of effluent were collected separately from the top and bottom screens rather than one sample from the combined flow from both screens.

The volume of water delivered to the circular screens was controlled by either of two methods. The pulley size on the pump could be changed to deliver a given volume or a gate valve on the discharge side of the pump could be restricted to reduce the flow.

Tests performed on the waste water samples included settleable solids and suspended solids. The moisture content of the solids was determined. For the two deck unit an estimate of the percentage of flow screened by each of the decks was made. The unscreened waste water passed through a 20 mesh Tyler screen and results from this test were considered as the control sample.

Table IX is a tabulation of average results obtained in 1967 with the single deck center discharge separator. At the bottom of the table results are shown for an experiment in which waste water screened by a 20 mesh vibrating screen was then pumped to the circular screen containing a 64 mesh screen.

TABLE IX

PERFORMANCE OF CENTER-DISCHARGE SEPARATOR IN SCREENING FRUIT WASTE EFFLUENT

| Type of Screen | Mesh Size | Suspended Solids (ppm) Influent | Suspended Solids (ppm) Effluent | Hydraulic Loading (GPM) (Circular vibrating screen) |
|---|---|---|---|---|
| Table Vibrating | 20 | 343 | 346 | |
| Circular Vibrating | 20 | 343 | 347 | 1000 |
| Table Vibrating | 20 | 418 | 447 | |
| Circular Vibrating | 40 | 526 | 527 | 500 - 600 |
| Table Vibrating | 20 | 360 | 366 | |
| Circular Vibrating | 48 | 360 | 248 | 500 |
| After passing through 20-mesh table vibrating screen onto: | | | | |
| Circular Vibrating | 64 | 1270 | 910 | 300 - 400 |

Located in the Appendix are the results obtained in 1968 with the two deck separator. Table X contains data to illustrate the effect of changing the mesh size of the top screen while maintaining a constant mesh size on the bottom screen.

TABLE X

EFFECT OF CHANGE IN MESH SIZE ON TOP SCREEN

| Mesh | | % Screened | | Suspended Solids (ppm) | | | |
|---|---|---|---|---|---|---|---|
| TOP | BOT. | TOP | BOT. | TYLER | TOP | BOT. | TABLE TOP |
| 20 | 78 | 99.9 | 0.1 | 440 | 564 | 1851 | 512 |
| 40 | 78 | 99.5 | 0.5 | 475 | 510 | 2080 | 535 |
| 48 | 78 | 99.5 | 0.5 | 496 | 499 | 3810 | 497 |
| 64 | 78 | 92.0 | 8.0 | 390 | 377 | 569 | 403 |
| 80 | 78 | 90.0 | 10.0 | 585 | 512 | 647 | 560 |
| 100 | 78 | 50.0 | 50.0 | 623 | 593 | 667 | 613 |

Table XI illustrates the effect of changing the mesh of the bottom screen while the top screen remains constant.

TABLE XI

EFFECT OF CHANGE OF MESH SIZE ON BOTTOM SCREEN

| Mesh | | % Screened | | Suspended Solids (ppm) | | | |
|---|---|---|---|---|---|---|---|
| TOP | BOT. | TOP | BOT. | TYLER | TOP | BOT. | TABLE TOP |
| 78 | 64 | 70.0 | 30.0 | 263 | 243 | 473 | 307 |
| 80 | 78 | 85.0 | 15.0 | 585 | 512 | 647 | 560 |
| 78 | 94 | 75.0 | 25.0 | 475 | 445 | 830 | 547 |
| 80 | 100 | 85.0 | 15.0 | 394 | 331 | 640 | 377 |

In looking down onto the top of the unit, before modification, the solids and the flow from the spreader arms were in the same direction. After changes were made, the solids still rotated in the same direction but the flow was in the opposite direction to the rotation of the solids. This change interrupted the tendency of the liquid to swirl around the outer edge of the top screen and also pushed the solids toward the center for discharge to the bottom screen. This change increased the screening capacity of the top screen and also removed the solids faster from the top deck. This was important because results have shown that in screening fruit waste, it was desirable to minimize the contact time between fruit solids and screen surface because of the grating action of the screen.

The single deck screen required the maintenance of solid wastes around the center discharge area to prevent water from discharging with the solids. Fine mesh screens required that the flow being screened had to be reduced; otherwise it was not possible to maintain solids around the discharge throat of the unit.

As a result of the 1967 experiments, the manufacturer of the center-discharge separator built a proto-type model to overcome most of the observed limitations of circular screens. The new unit had two screening decks rather than one. The top screen was in the same position as on the original unit, but an additional screen was placed directly below. With this arrangement, it should be possible to maintain a high volume, flow rate with the finer mesh screens. In operation, the new unit deliberately overflowed some water with solids into the center of the top screen. The second screen which has a solid center could then complete the separation of liquids from solids.

On September 12, 1968, a taller outer top frame was installed on the unit as well as new distribution or feeder arms. Additional height was added to the frame to eliminate occasional splashing of liquids over the side. The new spreader arms were installed to provide a minimum of 2 inches of clearance between the bottom surface of the spreader and the top surface of the screen. This was necessary to prevent large objects from lodging beneath the spreader arms. The discharge of the flow to the screen in relation to the travel of the solids on the top screen was also changed as illustrated in Figure 26.

During the 1968 test program peaches, pears, fruit cocktail and tomatoes were being processed by the cannery. At no time was it possible to obtain screening data while a single product was being canned. At the beginning of the test program, peaches were the major commodity being canned but there was also some solid waste from pear processing. Beginning August 1, 1968, peaches, pears and tomatoes were being processed on an approximate

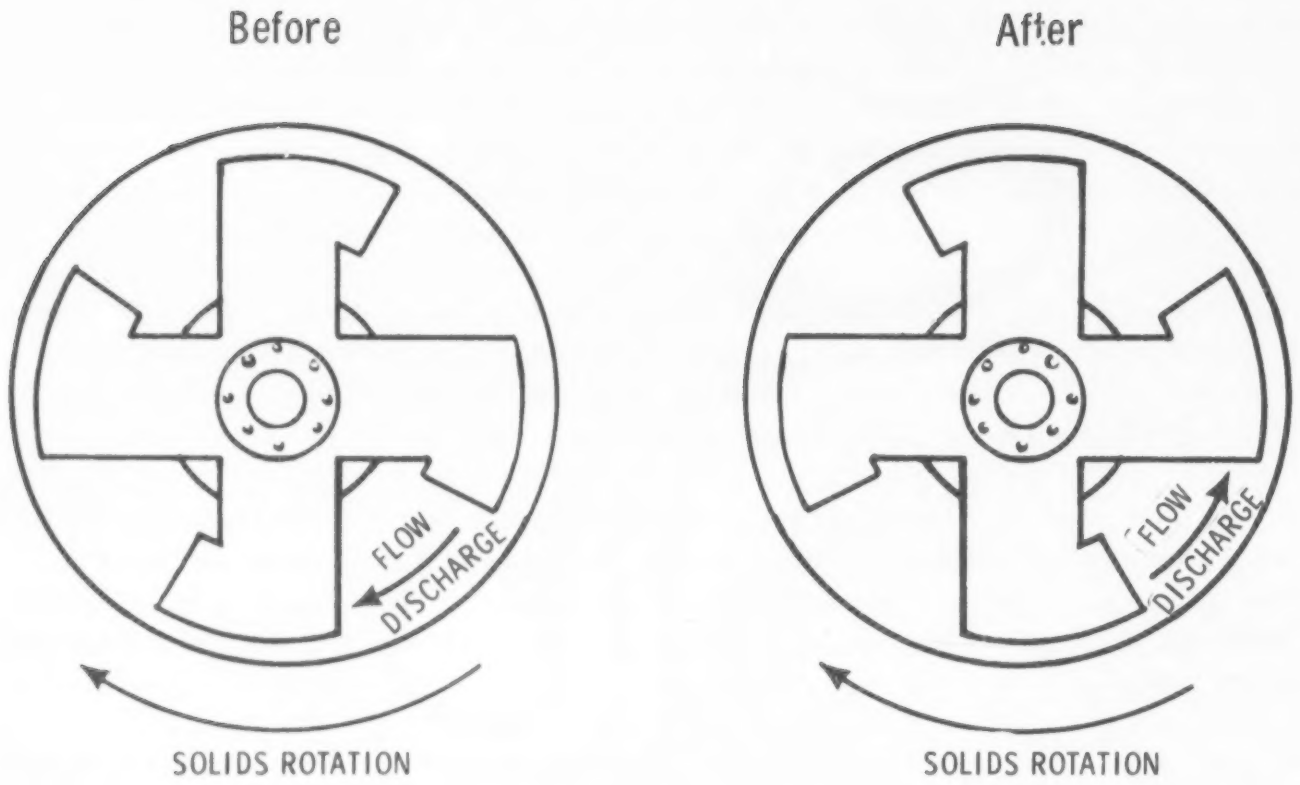


Figure 26. Change in direction of hydraulic flow.

equal basis. On August 28, the product mix consisted of cocktail and tomatoes. Then on September 23, primarily pears and tomatoes were processed by the cannery. With the beginning of October the major commodity processed was tomatoes although some waste was being generated from pears and this combination continued until the end of the test program.

Additional tests were made when the plant was processing mostly tomatoes. The results again showed that the center-discharge separator with fine mesh screens, was able to produce an effluent lower in suspended solids than the table vibrating separator using a 20 mesh screen. When the circular screen operated on tomato waste water, it was noted that pieces of peel did not lodge in the spaces between the screen wires as often occurs with other screens. Such "blinding" of the screen openings can cause flooding over the waste water into the screened solid material.

In 1967 tests were conducted to determine the feasibility of reducing the solids content of effluent waste waters by means of a circular vibrating screen. It was determined that fine mesh screens, equal to or greater than 48 mesh, could reduce the suspended solids of effluents when compared to conventional 20 mesh flat vibrating screens. It was noted that with the circular screen, the volume of feed had to be reduced as the fineness of the screens mesh increased, otherwise there was a flooding of liquid into the screened solids. It was further noted that low quantities of solids in the unscreened water made it difficult to prevent liquids from being discharged with the solids.

With a 40 mesh screen on the circular unit, the volume being screened had to be reduced to 500 to 600 gpm. There was no difference in the suspended solids content of the effluent from either of the screening systems. Using a 48 mesh screen, there was a difference in the suspended solids content of the effluent from the two types of screens. The circular screen reduced the suspended solids content by 31 percent as compared to the table screen. However, the flow rate for the circular screen had to be reduced to 400 to 500 gpm.

At the bottom of Table IX, results were given for an experiment in which the effluent from the 20 mesh vibrating screen was re-screened by the center-discharge separator using a 64 mesh screen. The suspended solids content was reduced an additional 28 percent with the finer mesh screen. Again the volume being screened had to be reduced, this time to 300 to 400 gpm.

Fine mesh screens installed on a single deck center-discharge separator did separate the gross solids from the liquid waste and also removed some suspended solids which pass through a 20 mesh screen. In most instances with fine mesh screens there was a reduction in the suspended solids of the effluent, when compared to the Tyler screen results which did not disentegrate the solids.

For runs using 20, 40, or 48 mesh on the top, almost all of the liquid-solid separation took place on the top screen. For these runs all of the solids which were rescreened on the bottom screen, were essentially "dry screened" and this resulted in the high suspended solids content for the bottom screen effluent. With the finer meshes on top (64, 80 and 100), some water was carried over from the top screen which was then removed by the bottom screen. The water on the bottom screen acted as a lubricant and prevented the solids from being subjected to a grating action of the screen.

It was shown in Table IX and illustrated again in Table X that if dry screening is prevented on the bottom screen, there will not be a significant increase in suspended solids content of the effluent from the bottom screen. In comparing results in Tables IX and X it can be seen that when a mesh of 64 or finer is used on the top screen, the suspended solids content will be less than from the conventional table top screen and from Tyler static screen test.

Generally, the suspended solids content of effluent from the bottom screen was high when the discharge volume was very low. This was a result of the solids being dry screened. This high suspended solids value was not found to be very significant when the flows from the top and bottom screens were weighted for the volumes of liquid being discharged by each screen. For examples, in Table IX where a combination of 20 and 78 mesh screens were used, 99.9 percent of the total volume was screened on the top deck and 0.1 percent screened on the bottom deck. The suspended solids from each screen was 564 and 1851 ppm respectively. If 1000 gpm was being screened by the unit under these conditions, then 999 gpm was discharged by the top screen and 1 gpm by the bottom screen. Converting these figures to pounds of suspended solids per day, it was found that the effluent from the top screen contained 812 pounds while only 2.56 pounds of suspended matter was in the bottom screen effluent.

## SECTION VIII

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Robert Foster, Contadina Division, Carnation Co., Van Nuys
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San Mateo, California 94401
Kenneth A. Paulson

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Taylor Instrument Companies
1661 Timothy Drive
San Leandro, California 94557
Wayne A. Langford

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Southwest Engineering Company (Sweco)
6111 East Bandini Blvd.
Los Angeles, California 90054
Jim K. McIntosh
Paul Miller
Robert Miller

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333 West Julian Street
San Jose, California 95108
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Harold Adams

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Bob Mitchell

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San Jose, California
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Richard Foster
Harold Redsun

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Walter A. Mercer
Project Director

Walter W. Rose
Project Leader

## SECTION IX

## GLOSSARY

An explanation of the headings for data on screens is as follows:

Mesh - refers to the top and bottom screens on the circular unit.

Percent screened - an estimate of the volume being screened by the top and bottom screens on the circular unit

Settleable solids - mls of material settled after one hour in an Imhoff cone.

a. Tyler - settleable solids obtained by passing a sample over a 20 mesh static screen. Used as a control for the two deck screen.
b. Top - settleable solids from the top screen of the two deck unit.
c. Bottom - settleable solids from the bottom screen of the two deck unit
d. Tyler - settleable solids from a 20 mesh static screen. Used as a control for the table top screen.
e. Table top effluent - settleable solids from the cannery operated 20 mesh vibrating screen

Suspended solids - milligrams per liter of material retained on a glass fiber filter paper

a. Tyler - suspended solids obtained by passing a sample over a 20 mesh static screen. Used as a control for the two deck screen.
b. Top - suspended solids from the top screen of the two deck unit
c. Bottom - suspended solids from the bottom screen of the two deck unit
d. Tyler - suspended solids from a 20 mesh static screen. Used as a control for the table top screen.
e. Table top effluent - suspended solids from the cannery operated 20 mesh vibrating screen

Percent moisture - amount of liquid in a sample obtained by drying to a constant weight in an oven (103°C).

## SECTION X
## APPENDICES


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# APPENDIX A

## HIGH RATE TRICKLING FILTER TREATMENT OF LIQUID WASTES

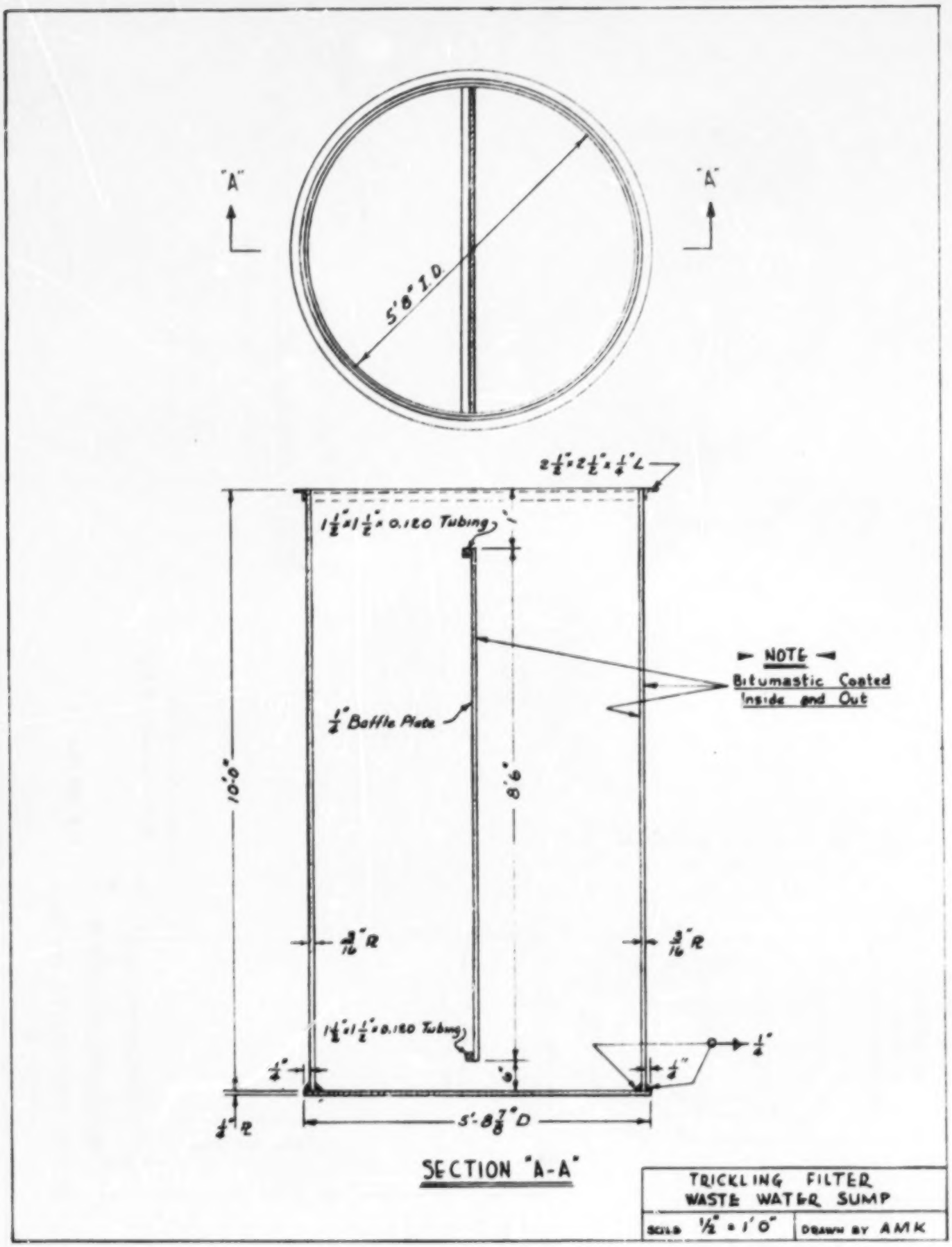
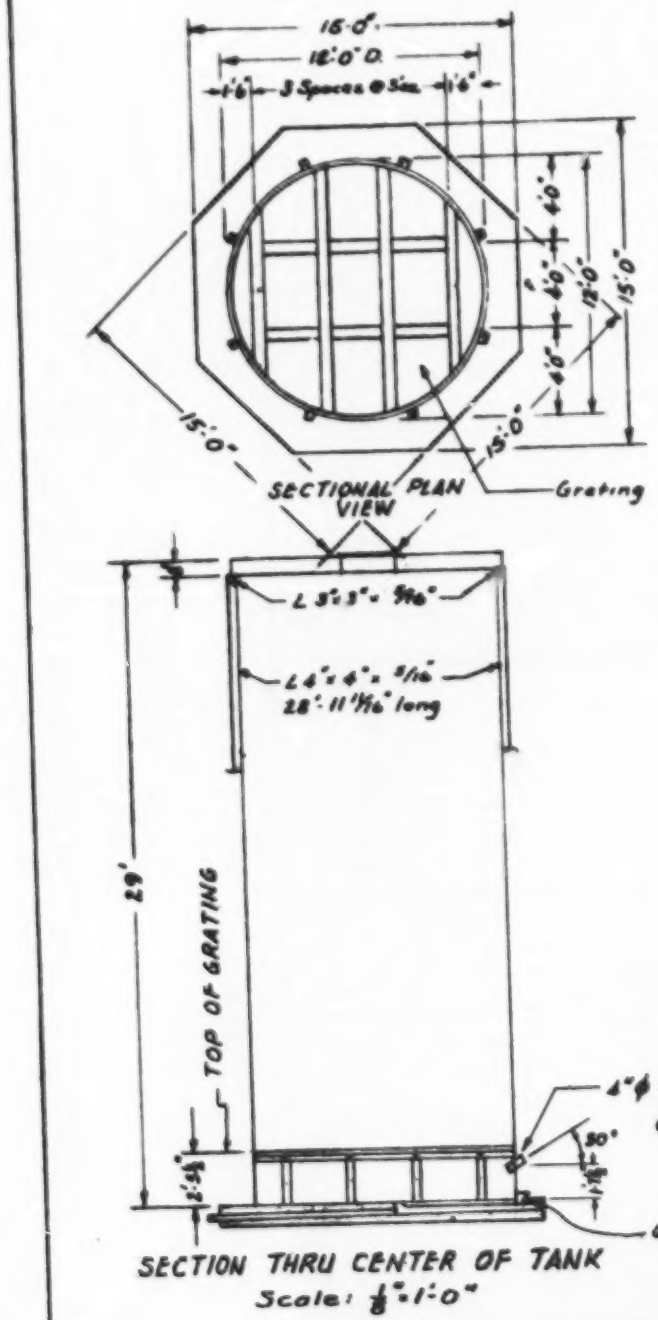
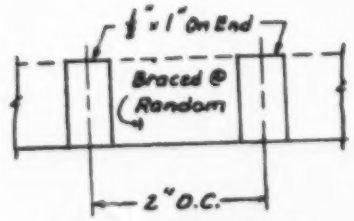

"A"
"A"
5'8" I.D.
2 1/8" x 2 1/2" x 1/4" ∠
1 1/2" x 1 1/2" x 0.120 Tubing
NOTE
Bitumastic Coated
Inside and Out
1/2" Baffle Plate
10'-0"
8'6"
3/16" R
3/16" R
1 1/2" x 1 1/2" x 0.120 Tubing
1/4"
1/4"
1/4"
1/4" R
5'-8 7/8" D
SECTION "A-A"
TRICKLING FILTER
WASTE WATER SUMP
SCALE 1/2" = 1'0"
DRAWN BY AMK

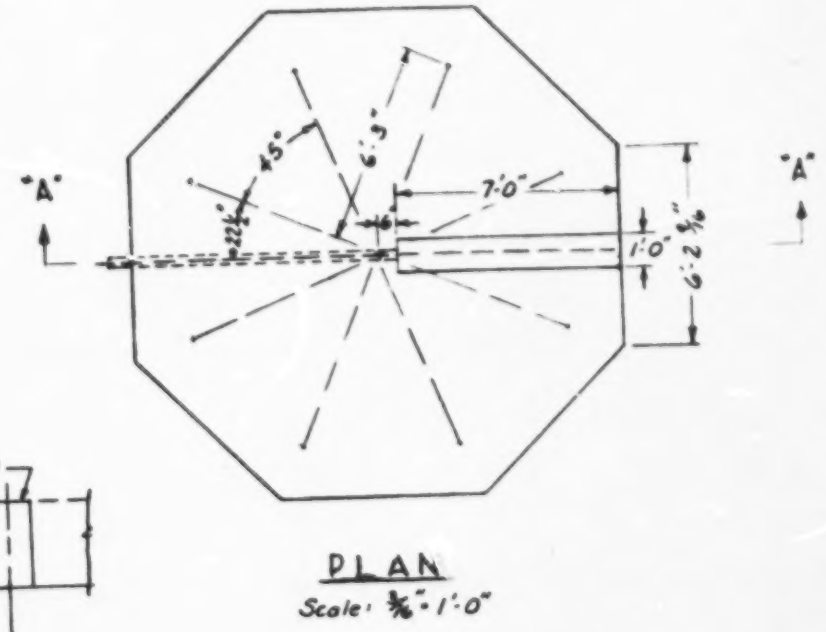
Figure A-1.



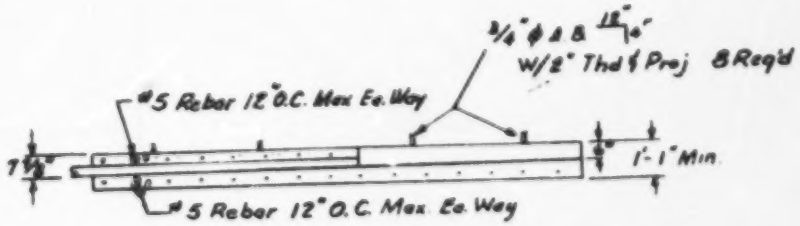

SECTION THRU CENTER OF TANK
Scale: 1/8" = 1'-0"




GRATING DETAIL
Scale: 6" = 1'-0"



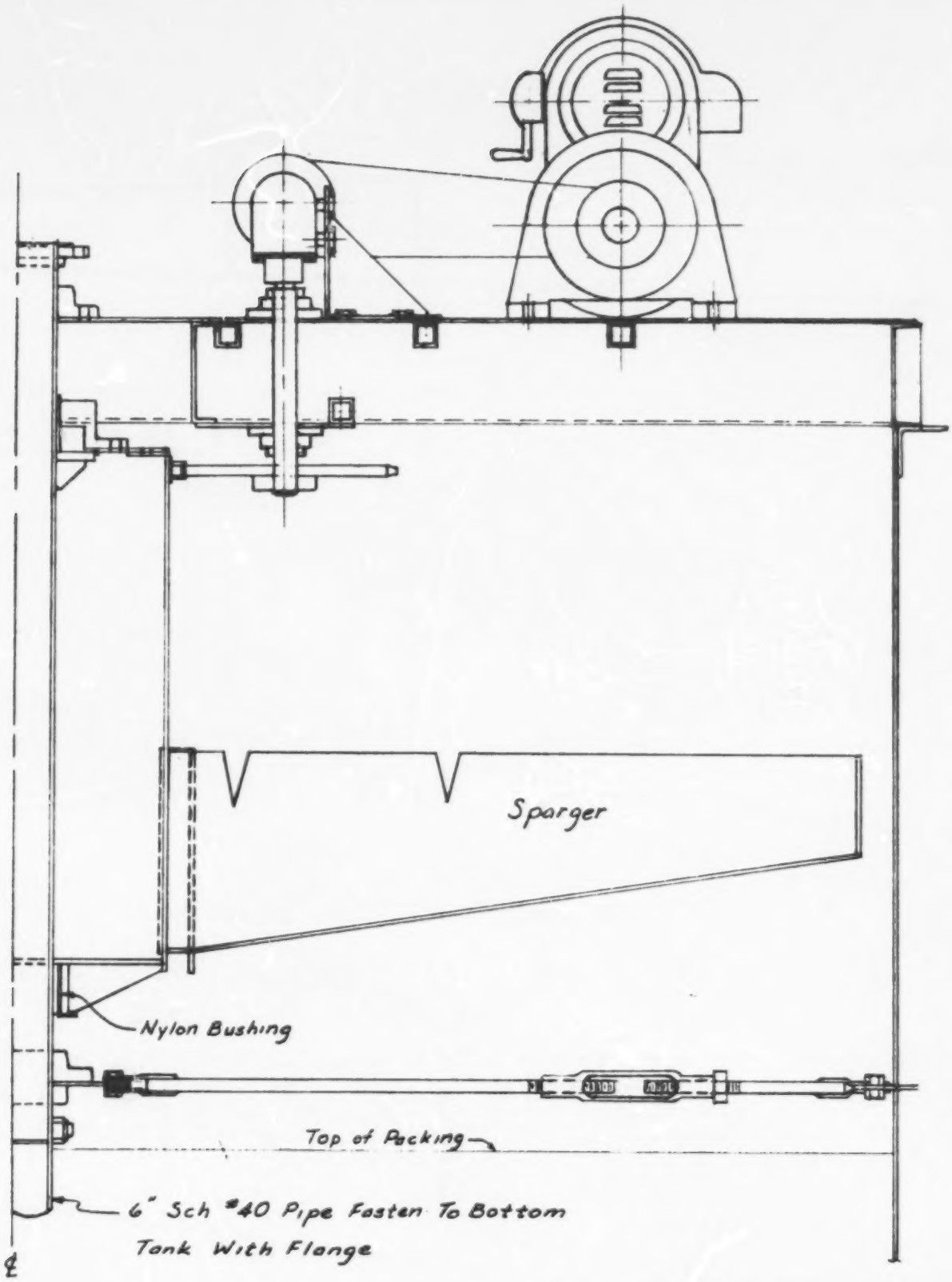

PLAN
Scale: 3/16" = 1'-0"




SECTION "A-A"
Scale: 3/16" = 1'-0"

| TRICKLING FILTER TANK & PAD | |
|---|---|
| Scale AS NOTED | DWG - B-67240-1 |

Figure A-2.




| SPARGER & DRIVE ASSEMBLY | |
|---|---|
| SCALE: 1"-1'-0" | DRAWN BY: ℄ |

Figure A-3.

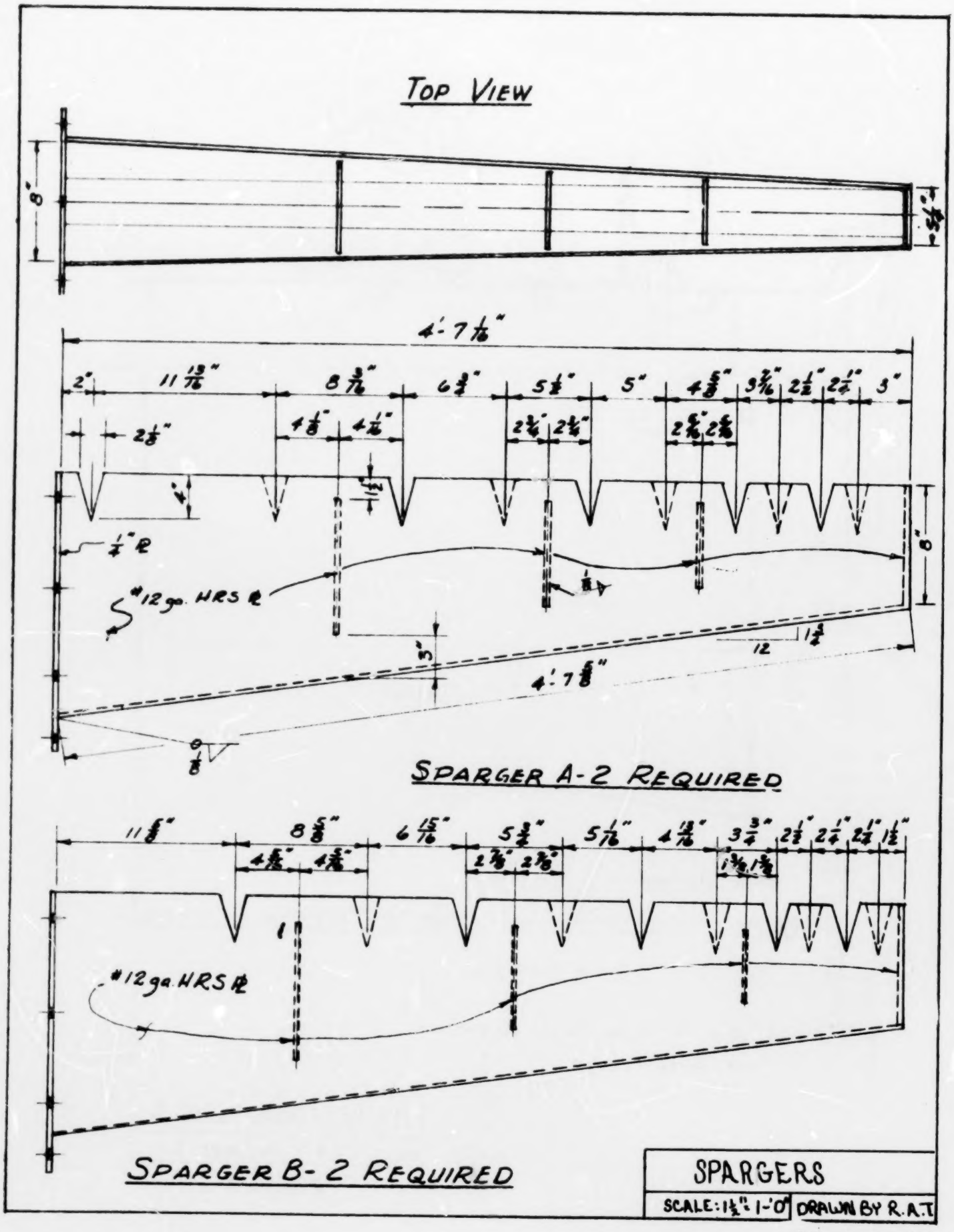
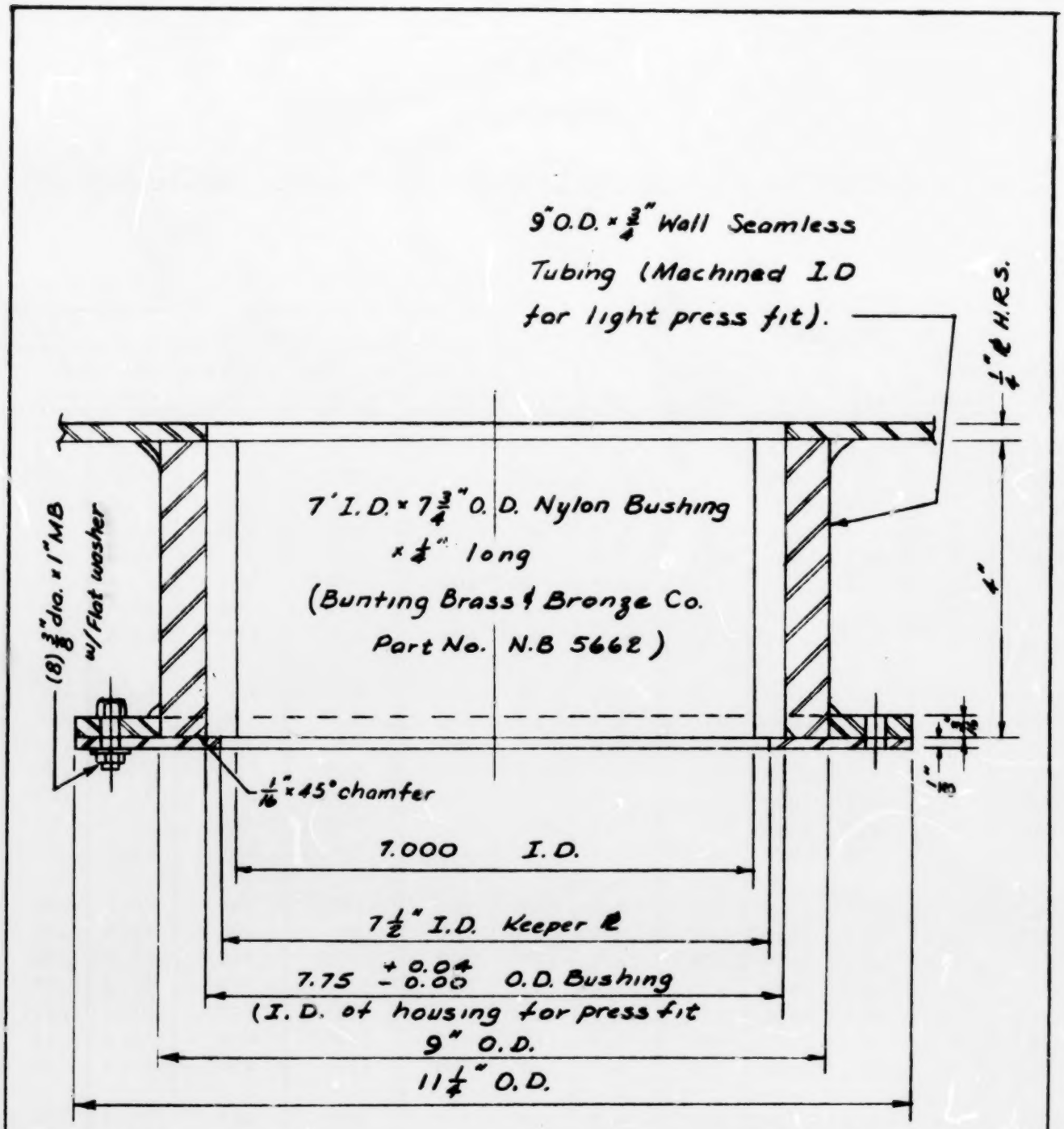

TOP VIEW
8"
4'-7 1/16"
2"
11 13/16"
8 3/16"
6 3/4"
5 1/2"
5"
4 5/8"
3 7/16"
2 1/2"
2 1/4"
3"
2 1/8"
4 1/8"
4 1/16"
2 7/16"
2 7/16"
2 5/16"
2 5/16"
1/4" ℄
#12 ga. HRS ℄
8"
5"
12
1 1/2
4'-7 5/8"
SPARGER A-2 REQUIRED
11 5/8"
8 5/8"
6 15/16"
5 3/4"
5 1/16"
4 13/16"
3 3/4"
2 1/2"
2 1/4"
2 1/2"
1 1/2"
4 5/8"
4 5/16"
2 7/16"
2 7/16"
1 3/16
1 3/16
#12 ga. HRS ℄
SPARGER B-2 REQUIRED
SPARGERS
SCALE: 1 1/2" = 1'-0"
DRAWN BY R.A.T

Figure A-4.


9" O.D. × 3/4" Wall Seamless Tubing (Machined I.D for light press fit).
1/4" R.H.R.S.
7" I.D. × 7 3/4" O.D. Nylon Bushing × 4" long
(Bunting Brass & Bronze Co. Part No. N.B 5662)
4"
(8) 3/8" dia. × 1" MB w/Flat washer
1/16" × 45° chamfer
7.000 I.D.
7 1/2" I.D. Keeper R
7.75 +0.04 -0.00 O.D. Bushing
(I.D. of housing for press fit
9" O.D.
11 1/4" O.D.

# NYLON BUSHING

| NYLON BUSHING | |
|---|---|
| SCALE: 6 = 1'-0" | DRAWN BY R. A. T. |

Figure A-5

TABLE I

TRICKLING FILTER TREATMENT OF FRUIT CANNING LIQUID WASTES

| Date 1968 | INFLUENT | | | | EFFLUENT | | | PERFORMANCE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hdly Load | pH | BOD | Susp. Sol. | pH | BOD | Susp. Sol. | Organ Load | Organ Rem. | Per-cent | K Fact |
| 8/1 | 0.66 | 5.3 | 1700 | - | 5.2 | 900 | - | 630 | 300 | 47.0 | .02 |
| 8/2 | " | - | 2370 | - | - | 1540 | - | 880 | 310 | 35.0 | .02 |
| 8/3 | " | 6.3 | 1890 | - | 6.4 | 980 | - | 700 | 380 | 48.0 | .03 |
| 8/5 | " | 6.2 | 2240 | - | 6.8 | 980 | 1100 | 830 | 650 | 79.0 | .06 |
| 8/6 | " | 6.1 | 1860 | 670 | 5.7 | 820 | 900 | 690 | 390 | 56.0 | .03 |
| 8/8 | " | 6.4 | 800 | 490 | 6.2 | 160 | 600 | 300 | 240 | 80.0 | .06 |
| 8/9 | " | - | 1240 | - | - | 850 | - | 460 | 150 | 32.0 | .01 |
| Ave. | " | 6.1 | 1730 | 580 | 6.1 | 890 | 870 | 640 | 350 | 54.0 | .03 |
| 8/13 | 0.88 | 7.5 | 1790 | - | 5.1 | 1540 | - | 890 | 120 | 13.8 | .01 |
| 8/16 | " | 719 | 1860 | 810 | 5.5 | 1530 | 600 | 920 | 160 | 17.2 | .01 |
| 8/17 | " | 6.4 | 2150 | 1030 | 5.2 | 1650 | 680 | 1090 | 250 | 23.5 | .01 |
| 8/19 | " | 6.7 | 2000 | 850 | 5.5 | 1610 | 1060 | 990 | 200 | 19.2 | .01 |
| 8/20 | " | 8.1 | 1800 | 620 | 5.5 | 1400 | 720 | 890 | 200 | 22.0 | .01 |
| 8/21 | " | 8.8 | 1940 | 670 | 5.4 | 1500 | 1880 | 970 | 220 | 22.3 | .01 |
| Ave. | " | 7.6 | 1920 | 800 | 5.4 | 1540 | 990 | 950 | 190 | 19.7 | .01 |
| 8/22 | 0.88 | 7.5 | 2250 | 670 | 6.8 | 1430 | 910 | 1120 | 410 | 36.4 | .02 |
| 8/23 | " | 8.6 | 2330 | 550 | 6.7 | 1040 | 330 | 1150 | 640 | 55.5 | .04 |
| 8/24 | " | 8.4 | 2010 | 620 | 6.6 | 1270 | 740 | 1000 | 360 | 36.3 | .02 |
| 8/28 | " | 5.2 | 2530 | 870 | 5.9 | 1840 | 510 | 1260 | 340 | 27.2 | .01 |
| 8/29 | " | 5.5 | 2490 | 590 | 5.8 | 1750 | 400 | 1230 | 370 | 29.7 | .02 |
| 8/31 | " | 6.1 | 2410 | 950 | 5.8 | 1190 | 1330 | 1190 | 600 | 50.4 | .03 |
| Ave. | " | 6.9 | 2340 | 710 | 6.3 | 1420 | 700 | 1160 | 450 | 39.3 | .02 |
| 9/4 | 1.54 | 6.8 | 2180 | 600 | 6.5 | 1650 | 380 | 1890 | 460 | 24.4 | .02 |
| 9/5 | " | 6.6 | 2310 | 800 | 6.4 | 1720 | 840 | 2000 | 510 | 25.5 | .02 |
| 9/7 | " | 4.8 | 2020 | 1040 | 4.6 | 1560 | 820 | 1750 | 390 | 22.5 | .02 |
| 9/9 | " | 6.6 | 1710 | 1190 | 5.0 | 1250 | 930 | 1480 | 400 | 26.8 | .02 |
| 9/10 | " | 7.8 | 1450 | 560 | 5.6 | 960 | 540 | 1250 | 430 | 34.0 | .02 |
| 9/13 | " | 8.4 | 1260 | 560 | 5.6 | 880 | 390 | 1090 | 330 | 30.0 | .02 |
| 9/14 | " | 5.5 | 1620 | 530 | 4.9 | 1300 | 600 | 1400 | 270 | 19.5 | .01 |
| Ave. | " | 6.7 | 1790 | 750 | 5.5 | 1330 | 640 | 1550 | 400 | 26.1 | .02 |

The units used in Table I are:

a. hydraulic rate: gallons per minute waste per square foot of cross-sectional area

b. B.O.D. milligrams per liter

c. organic loading: pounds of B.O.D. per 1000 cubic feet of packing medium per day

d. suspended solids: milligrams per liter

e. organic removal: pounds of B.O.D. removed per 1000 cubic feet of packing medium per day

f. K factor: is a treatability factor which is defined by the equation:

$$L_e = e - KD/Q1/2$$

Where $L_o$ = ppm B.O.D. influent

$L_e$ = ppm B.O.D. remaining

K = rate coefficient

D = depth of filter medium in feet

Q = fresh waste in gallons per minute per square of surface area

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# APPENDIX B

## pH CONTROL OF RECIRCULATED FLUME WATER

TABLE I
RESULTS FOR ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/l $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-14 | 6 am | 72 | 7.1 | 39 | ----- |
| | 7 am | 72 | 3.8 | 557 | ----- |
| | 8 am | 74 | 3.8 | 581 | ----- |
| | 9 am | 72 | 3.7 | 685 | ----- |
| | 10 am | 74 | 4.1 | 343 | ----- |
| | 11 am | 75 | 3.7 | 649 | ----- |
| | Noon | 75 | 3.7 | 649 | 110 |
| | 1 pm | 83 | 3.1 | 3650 | 120 |
| | 2 pm | 76 | 3.4 | 1283 | 60 |
| | 3 pm | 75 | 3.4 | 880 | 470 |
| | 4 pm | 76 | 4.1 | --- | 50 |
| | 6 pm | 75 | 4.1 | 429 | 820 |
| | 8 pm | 73 | 3.3 | 241 | 890 |
| | 9 pm | 71 | 3.0 | 1750 | ----- |
| | 10 pm | 74 | 4.4 | 337 | ----- |
| | 11 pm | 73 | 3.8 | 715 | 370 |
| | MD | 72 | 3.8 | 811 | 210 |
| | 1 am | 73 | 3.8 | 809 | ----- |
| | 3 am | 71 | 4.0 | 483 | 40 |
| | 5 am | 73 | 3.9 | 540 | 300 |
| | 6 am | 73 | 4.0 | 506 | 50 |
| 8-15 | 7 am | 69 | 3.4 | 1298 | 50 |
| | 9 am | 72 | 4.2 | 299 | 1680 |
| | 11 am | 74 | 3.8 | 843 | 90 |
| | Noon | 73 | 5.5 | 68 | 2500 |
| | 2 pm | 74 | 3.8 | 752 | 90 |
| | 4 pm | 72 | 3.6 | 889 | ----- |
| | 5 pm | 71 | 3.2 | 976 | 80 |

TABLE I (CONT.)

RESULTS FOR ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/l $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-15 | 7 pm | 71 | 4.2 | 210 | 90 |
| | 9 pm | 71 | 4.3 | 199 | 1170 |
| | 10 pm | 71 | 4.0 | 326 | 2810 |
| | 11 pm | 71 | 4.3 | 210 | 2000 |
| | MD | 73 | 4.2 | 282 | 5830 |
| | 1 am | 71 | 3.9 | 382 | 420 |
| | 3 am | 68 | 4.2 | 177 | 90 |
| | 5 am | 72 | 3.9 | 406 | 600 |
| 8-16 | 6 am | 68 | 3.9 | 324 | 100 |
| | 8 am | 70 | 4.5 | 130 | 240 |
| | 9 am | 70 | 3.7 | 473 | 10 |
| | 11 am | 68 | 4.1 | 246 | 10 |
| | Noon | 73 | 4.1 | 230 | ----- |
| | 1 pm | 72 | 4.2 | 310 | 390 |
| | 2 pm | 73 | 4.1 | 380 | 590 |
| | 4 pm | 75 | 4.3 | 245 | 60 |
| | 6 pm | 75 | 4.6 | 126 | 109 |
| | 8 pm | 73 | 4.2 | 263 | 750 |
| | 10 pm | 73 | 4.0 | 326 | 210 |
| | MD | 75 | 4.6 | 192 | 680 |
| | 1 am | 74 | 4.6 | 193 | 520 |
| | 3 am | 71 | 3.8 | 602 | 300 |
| | 5 am | 73 | 3.9 | 564 | 160 |
| 8-17 | 6 am | 68 | 4.5 | 156 | ----- |
| | 7 am | 72 | 3.9 | 462 | 3000 |
| | 9 am | 80 | 4.4 | 487 | 860 |
| | 11 am | 77 | 3.5 | 1348 | 500 |
| | 1 pm | 79 | 4.0 | 838 | 400 |
| | 3 pm | 77 | 4.6 | 244 | 260 |

TABLE I (CONT.)

RESULTS FOR ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/l $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-17 | 5 pm | 81 | 4.0 | 708 | 240 |
| | 8 pm | 68 | 4.2 | 129 | 150 |
| | 9 pm | 68 | 4.2 | 160 | 65 |
| | 11 pm | 75 | 4.5 | 258 | 800 |
| | MD | 75 | 4.1 | 399 | 700 |
| | 1 am | 75 | 3.7 | 737 | 120 |
| | 3 am | 70 | 4.1 | 234 | 20 |
| | 5 am | 67 | 4.0 | 240 | 980 |
| 8-18 | 6 am | 68 | 4.3 | 178 | 80 |
| | 8 am | 73 | 4.2 | 303 | 295 |
| | 10 am | 73 | 4.0 | 597 | 90 |
| | Noon | 73 | 4.0 | 518 | 161 |
| | 2 pm | 82 | 3.3 | 1227 | 73 |
| | 4 pm | 78 | 3.5 | 1022 | 75 |
| | 5 pm | 75 | 4.4 | 290 | 900 |
| | 7 pm | 73 | 3.7 | 450 | 343 |
| | 9 pm | 70 | 4.10 | 215 | 80 |
| | 11 pm | 75 | 3.8 | 590 | 200 |
| | 1 am | 75 | 4.2 | 332 | 800 |
| | 3 am | 68 | 3.78 | 273 | 100 |
| | 5 am | 67 | 6.2 | 73 | 690 |
| 8-19 | 6 am | 67 | 4.5 | ---- | ----- |
| | 7 am | 68 | 3.6 | 354 | 10 |
| | 9 am | 75 | 4.3 | 276 | 430 |
| | 11 am | 72 | 4.2 | 341 | 400 |
| | 1 pm | 75 | 3.8 | 677 | 120 |
| | 2 pm | 75 | 5.5 | 96 | 350 |
| | 4 pm | 78 | 4.0 | 552 | 30 |
| | 6 pm | 76 | 4.0 | 410 | 100 |
| | 8 pm | 75 | 3.9 | 422 | 270 |

TABLE I (CONT.)
RESULTS FOR ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/l $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-19 | 10 pm | 76 | 3.9 | 562 | 880 |
| | MD | 77 | 3.8 | 910 | 840 |
| | 2 am | 77 | 4.1 | 467 | 800 |
| | 4 am | 77 | 3.8 | 921 | 300 |
| | 5 am | 77 | 4.2 | 622 | 230 |
| 9-8 | 6 am | 68 | 6.6 | 25 | <1 |
| | 8 am | 69 | 4.1 | 390 | 300 |
| | 10 am | 71 | 4.2 | 306 | 400 |
| | Noon | 70 | 4.0 | 352 | 24 |
| | 2 pm | 71 | 3.3 | 820 | 59 |
| | 4 pm | 72 | 3.7 | 650 | 14 |
| | 6 pm | 70 | 4.2 | 340 | 9 |
| | 8 pm | 71 | 4.1 | 330 | 30 |
| | 10 pm | 67 | 3.8 | 520 | 45 |
| 9-9 | 6 am | 67 | 4.4 | 180 | <1 |
| | 8 am | 72 | 4.1 | 412 | 63 |
| | 10 am | 75 | 3.9 | 604 | 72 |
| | Noon | 72 | 3.8 | 506 | 37 |
| | 2 pm | 75 | 3.5 | 835 | 84 |
| | 4 pm | 74 | 3.9 | 506 | 61 |
| | 6 pm | 73 | 4.0 | 400 | 97 |
| | 7 pm | 72 | 3.5 | 320 | 172 |
| | 9 pm | 74 | 4.1 | 500 | 806 |
| | 10 pm | 71 | 4.4 | 285 | 520 |
| 9-11 | 6 am | 68 | 3.9 | 448 | 41 |
| | 7 am | 70 | 4.0 | 447 | 67 |
| | 8 am | 71 | 3.8 | 552 | 13 |

TABLE I (CONT.)
RESULTS FOR ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/l $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 9-11 | 10 am | 76 | 3.4 | 1135 | 23 |
| | Noon | 71 | 3.6 | 646 | 2 |
| | 2 pm | 75 | 3.8 | 593 | 17 |
| | 4 pm | 72 | 4.2 | 313 | 10 |
| | 6 pm | 73 | 4.1 | 352 | 112 |
| | 8 pm | 74 | 4.1 | 351 | 112 |
| | 10 pm | 72 | 4.2 | 372 | 161 |
| 9-15 | 6 am | 69 | 6.5 | 11 | <1 |
| | 8 am | 69 | 4.2 | 272 | 76 |
| | 9 am | 75 | 3.7 | 965 | 510 |
| | 10 am | 74 | 3.8 | 841 | 440 |
| | 11 am | 78 | 3.5 | 1800 | 300 |
| | Noon | 77 | 3.4 | 1900 | 650 |
| | 1 pm | 79 | 3.5 | 1500 | 970 |
| | 2 pm | 77 | 3.5 | 1200 | 440 |
| | 3 pm | 78 | 3.5 | 1300 | 710 |
| | 5 pm | 77 | 3.9 | 696 | 160 |
| 9-16 | 6 am | 68 | 3.9 | 340 | <1 |
| | 8 am | 74 | 3.6 | 976 | 100 |
| | 10 am | 77 | 3.8 | 878 | 530 |
| | Noon | 73 | 3.5 | 853 | 80 |
| | 2 pm | 77 | 3.9 | 722 | 280 |
| | 4 pm | 77 | 3.9 | 778 | 600 |
| | 6 pm | 77 | 3.8 | 742 | 186 |
| | 7 pm | 75 | 3.8 | 652 | 220 |
| 9-20 | 6 am | 67 | 7.4 | 19 | <1 |

TABLE I (CONT.)
RESULTS FOR ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/l $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 9-20 | 8 am | 70 | 4.7 | 161 | 122 |
| | 10 am | 73 | 4.0 | 462 | 43 |
| | 11 am | 75 | 4.0 | 486 | 184 |
| | 1 pm | 77 | 4.1 | 441 | 77 |
| | 3 pm | 73 | 4.1 | 341 | 50 |
| | 5 pm | 75 | 3.9 | 525 | 50 |
| | 7 pm | 75 | 3.8 | 508 | ----- |
| | 9 pm | 78 | 3.9 | 694 | 159 |
| 9-22 | 10 am | 76 | 4.1 | 514 | 660 |
| | Noon | 72 | 4.1 | 318 | 110 |
| | 2 pm | 77 | 4.4 | 400 | 140 |
| | 4 pm | 76 | 4.1 | 491 | 320 |
| | 6 pm | 75 | 3.9 | 574 | 690 |
| | 8 pm | 74 | 4.1 | 382 | 139 |
| | 9 pm | 76 | 4.2 | 467 | 249 |
| 9-23 | 6 am | 68 | 7.4 | 37 | <1 |
| | 7 am | 70 | 4.1 | 312 | 205 |
| | 8 am | 74 | 4.2 | 441 | 186 |
| | 9 am | 76 | 4.2 | 545 | 160 |
| | 10 am | 74 | 4.2 | 422 | 112 |
| | 11 am | 73 | 4.5 | 233 | 287 |
| | Noon | 74 | 4.4 | 180 | 113 |
| | 1 pm | 76 | 4.7 | 198 | 107 |
| | 2 pm | 76 | 4.6 | 202 | 79 |
| | 3 pm | 75 | 4.3 | 322 | 166 |
| | 4 pm | 75 | 4.2 | 370 | 44 |
| | 5 pm | 75 | 4.1 | 454 | 41 |

TABLE II

RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-14 | 6 am | 70 | 7.2 | 36 | ----- |
| | 7 am | 70 | 7.0 | 33 | ----- |
| | 8 am | 71 | 7.0 | 40 | ----- |
| | 9 am | 70 | 7.0 | 35 | ----- |
| | 10 am | 73 | 6.9 | 62 | ----- |
| | 11 am | 72 | 6.8 | 60 | ----- |
| | Noon | 70 | 6.9 | 43 | ----- |
| | 1 pm | 72 | 7.0 | 37 | 680 |
| | 2 pm | 73 | 6.8 | 61 | 1000 |
| | 3 pm | 73 | 7.1 | 43 | 223 |
| | 4 pm | 72 | 7.1 | 43 | 359 |
| | 6 pm | 73 | 6.5 | 131 | 252 |
| | 8 pm | 69 | 7.2 | 37 | 400 |
| | 9 pm | 69 | 7.2 | 57 | 150 |
| | 10 pm | 71 | 7.0 | 60 | 460 |
| | 11 pm | 71 | 7.0 | 74 | 340 |
| | MD | 70 | 7.1 | 70 | 250 |
| | 1 am | 71 | 7.0 | 68 | 620 |
| | 3 am | 68 | 7.1 | 60 | 170 |
| | 5 am | 69 | 7.1 | 58 | 380 |
| | 6 am | 71 | 7.2 | 55 | 420 |
| 8-15 | 7 am | 66 | 7.1 | 52 | 785 |
| | 9 am | 72 | 7.0 | 65 | 300 |
| | 11 am | 70 | 7.1 | 51 | 180 |
| | Noon | 70 | 7.0 | 54 | 450 |

TABLE II (CONT.)
RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-15 | 2 pm | 72 | 6.9 | 62 | 450 |
| | 4 pm | 70 | 6.9 | 71 | ----- |
| | 5 pm | 71 | 7.0 | 39 | 320 |
| | 7 pm | 69 | 6.9 | 41 | 80 |
| | 9 pm | 72 | 7.2 | 47 | 200 |
| | 10 pm | 73 | 7.3 | 37 | 370 |
| | 11 pm | 73 | 7.2 | 38 | 270 |
| | MD | 71 | 7.1 | 44 | 500 |
| | 1 am | 70 | 7.3 | 34 | 320 |
| | 3 a m | 69 | 7.4 | 27 | 700 |
| | 5 am | 69 | 7.1 | 46 | 530 |
| 8-16 | 6 am | 68 | 7.5 | 33 | 380 |
| | 8 am | 69 | 7.1 | 35 | 1900 |
| | 9 am | 70 | 7.1 | 33 | 900 |
| | 11 am | 68 | 7.4 | 29 | ----- |
| | Noon | 72 | 7.2 | 35 | 750 |
| | 1 pm | 74 | 7.2 | 39 | 130 |
| | 2 pm | 74 | 7.1 | 41 | 342 |
| | 4 pm | 73 | 7.2 | 40 | 1620 |
| | 6 pm | 72 | 7.3 | 37 | 1520 |
| | 8 pm | 71 | 7.2 | 47 | 1050 |
| | 10 pm | 69 | 7.4 | 30 | 370 |
| | MD | 72 | 7.3 | 51 | 1430 |
| | 1 am | 71 | 7.3 | 30 | 630 |
| | 3 pm | 69 | 7.3 | 30 | 400 |
| | 5 pm | 70 | 7.2 | 36 | 360 |

TABLE II (CONT.)
RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-17 | 6 am | 68 | 7.1 | 44 | ------- |
| | 7 am | 69 | 7.0 | 41 | 4500 |
| | 9 am | 70 | 7.0 | 51 | 3900 |
| | 11 am | 71 | 6.6 | 86 | 350 |
| | 1 pm | 72 | 7.0 | 45 | 220 |
| | 3 pm | 71 | 7.2 | 33 | 210 |
| | 5 pm | 73 | 6.8 | 44 | 280 |
| | 8 pm | 67 | 7.5 | 16 | ------- |
| | 9 pm | 67 | 7.6 | 21 | 160 |
| | 11 pm | 71 | 7.4 | 27 | 340 |
| | MD | 69 | 7.3 | 31 | ------- |
| | 1 am | 71 | 7.0 | 56 | 260 |
| | 3 am | 72 | 7.4 | 29 | 700 |
| | 5 am | 67 | 7.5 | 25 | 160 |
| 8-18 | 6 am | 68 | 7.2 | 26 | 8 |
| | 8 am | 69 | 7.2 | 31 | 177 |
| | 10 am | 70 | 7.2 | 34 | 171 |
| | Noon | 70 | 7.3 | 33 | 400 |
| | 2 pm | 68 | 7.5 | 34 | 300 |
| | 4 pm | 71 | 6.9 | 39 | 700 |
| | 5 pm | 71 | 7.3 | 30 | 700 |
| | 7 pm | 70 | 7.6 | 33 | 200 |
| | 9 pm | 68 | 7.5 | 23 | 500 |
| | 11 pm | 70 | 7.4 | 29 | 140 |
| | 1 am | 72 | 7.4 | 34 | 240 |
| | 3 am | 68 | 7.7 | 21 | 1010 |

TABLE II (CONT.)
RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 8-19 | 6 am | 67 | 7.1 | --- | ------ |
| | 7 am | 67 | 7.3 | 33 | 20 |
| | 9 am | 69 | 7.0 | 46 | 270 |
| | 11 am | 70 | 6.9 | 52 | 500 |
| | 1 pm | 72 | 6.8 | 72 | 275 |
| | 2 pm | 70 | 7.5 | 48 | 550 |
| | 4 pm | 76 | 6.8 | 59 | 230 |
| | 6 pm | 73 | 6.8 | 60 | 400 |
| | 8 pm | 73 | 7.0 | 45 | 1200 |
| | 10 pm | 73 | 6.8 | 69 | 570 |
| | MD | 73 | 6.9 | 53 | 500 |
| | 2 am | 73 | 7.2 | 36 | ------ |
| | 4 am | 73 | 7.2 | 34 | 380 |
| | 5 am | 73 | 6.9 | 49 | 530 |
| 9-8 | 6 am | 68 | 7.4 | 32 | <1 |
| | 8 am | 68 | 7.2 | 35 | 900 |
| | 10 am | 69 | 7.2 | 31 | 1230 |
| | Noon | 69 | 7.4 | 28 | 600 |
| | 2 pm | 69 | 7.5 | 16 | 77 |
| | 4 pm | 69 | 7.3 | 27 | 99 |
| | 6 pm | 68 | 7.4 | 31 | 87 |
| | 8 pm | 69 | 7.2 | 27 | 76 |
| | 10 pm | 67 | 7.3 | 31 | 253 |
| 9-9 | 6 am | 67 | 7.6 | 21 | <1 |
| | 8 am | 70 | 7.2 | 32 | 138 |
| | 10 am | 72 | 7.3 | 31 | 226 |

TABLE II (CONT.)
RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 9-9 | Noon | 70 | 7.4 | 23 | 106 |
| | 2 pm | 74 | 7.5 | 34 | 137 |
| | 4 pm | 70 | 7.5 | 30 | 111 |
| | 6 pm | 71 | 7.4 | 28 | 60 |
| | 7 pm | 69 | 7.6 | 32 | 1180 |
| | 9 pm | 71 | 7.1 | 34 | 1340 |
| | 10 pm | 70 | 7.4 | 26 | 1200 |
| 9-11 | 6 am | 67 | 7.7 | 16 | 82 |
| | 7 am | 69 | 7.4 | 27 | 80 |
| | 8 am | 69 | 7.4 | 27 | 22 |
| | 10 am | 72 | 7.2 | 33 | 59 |
| | Noon | 69 | 7.5 | 20 | 9 |
| | 2 pm | 71 | 7.4 | 23 | 53 |
| | 4 pm | 71 | 7.4 | 25 | 18 |
| | 6 pm | 70 | 7.3 | 25 | 54 |
| | 8 pm | 70 | 7.0 | 29 | 44 |
| | 10 pm | 69 | 7.2 | 30 | 22 |
| 9-15 | 5 am | 68 | 7.7 | 17 | <1 |
| | 8 am | 69 | 7.3 | 23 | 120 |
| | 9 am | 70 | 7.2 | 35 | 220 |
| | 10 am | 69 | 7.5 | 24 | 80 |
| | 11 am | 71 | 7.2 | 32 | 210 |
| | Noon | 69 | 7.4 | 23 | 510 |
| | 1 pm | 71 | 7.4 | 27 | 161 |
| | 2 pm | 71 | 7.2 | 30 | 270 |
| | 3 pm | 72 | 7.1 | 31 | 310 |

TABLE II (CONT.)
RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 9-15 | 5 pm | 72 | 7.2 | 34 | 910 |
| 9-16 | 6 am | 67 | 7.5 | 18 | <1 |
| | 8 am | 69 | 7.0 | 34 | 40 |
| | 10 am | 70 | 7.2 | 29 | 80 |
| | Noon | 69 | 7.4 | 21 | 30 |
| | 2 pm | 71 | 7.2 | 34 | 70 |
| | 4 pm | 70 | 7.3 | 31 | 200 |
| | 6 pm | 71 | 7.3 | 29 | 1800 |
| | 7 pm | 71 | 7.1 | 37 | 1500 |
| 9-20 | 6 am | 67 | 7.4 | 20 | <1 |
| | 8 am | 68 | 7.5 | 18 | 284 |
| | 10 am | 70 | 7.4 | 19 | ----- |
| | 11 am | 72 | 7.2 | 34 | 970 |
| | 1 pm | 73 | 7.1 | 36 | 115 |
| | 3 pm | 71 | 7.5 | 18 | 210 |
| | 5 pm | 73 | 7.1 | 36 | 115 |
| | 7 pm | 71 | 7.5 | 22 | ----- |
| | 9 pm | 74 | 7.1 | 40 | 153 |
| 9-22 | 10 am | 72 | 7.1 | 40 | 450 |
| | Noon | 69 | 7.6 | 16 | ---- |
| | 2 pm | 72 | 7.2 | 40 | 214 |
| | 4 pm | 71 | 7.3 | 31 | 168 |
| | 6 pm | 72 | 6.9 | 49 | 241 |
| | 8 pm | 70. | 7.3 | 26 | 337 |
| | 9 pm | 72 | 7.1 | 42 | 3050 |

TABLE II (CONT.)
RESULTS FOR NON ACIDIFIED PUMPING SYSTEM

| Date 1967 | Time | Temp. °F | pH | mg/L $CaCO_3$ | Relative Bact. Count |
|---|---|---|---|---|---|
| 9-23 | 6 am | 68 | 7.4 | 40 | 119 |
| | 7 am | 68 | 7.4 | 39 | 85 |
| | 8 am | 68 | 7.4 | 39 | 159 |
| | 9 am | 72 | 7.0 | 50 | 210 |
| | 10 am | 70 | 7.2 | 34 | 1210 |
| | 11 am | 72 | 7.1 | 37 | 1130 |
| | Noon | 72 | 7.0 | 50 | 220 |
| | 1 pm | 72 | 7.1 | 43 | 96 |
| | 2 pm | 74 | 7.0 | 45 | 600 |
| | 3 pm | 73 | 7.1 | 62 | 320 |
| | 4 pm | 73 | 7.2 | 37 | 70 |
| | 5 pm | 72 | 7.2 | 31 | 130 |

# APPENDIX C

## AIR FLOTATION FOR REMOVAL OF SUSPENDED SOLIDS

TABLE I

AIR FLOTATION - PEACH RINSE WATER

| 1967 | | Flow - GPM | | Loading | | Suspended Solids | | | Float | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | In | Recycle | GPM/ft$^2$ | lb/hr/ft$^2$ | In | Out | % Rem. | GPM | % Solids |
| 8-28 | 9-12am | 7.5 | 7.5 | 0.97 | 0.59 | 1560 | 20 | 98.6 | 0.49 | 1.44 |
| | 8-11pm | " | " | " | 0.33 | 880 | 18 | 98.0 | 0.49 | 1.82 |
| 8-29 | 6-9 am | " | " | " | 0.49 | 1310 | 44 | 96.6 | 0.54 | 1.68 |
| | 10-1 pm | " | " | " | 0.88 | 2340 | 188 | 92.6 | 0.72 | 0.97 |
| | 3-6 pm | " | " | " | 0.45 | 1190 | 62 | 94.7 | 0.72 | 2.86 |
| | 7-10pm | " | " | " | 0.38 | 1020 | 134 | 86.8 | 0.72 | 2.33 |
| | 11-2 am | " | " | " | 0.90 | 2390 | 84 | 96.5 | 0.72 | 1.34 |
| 8-30 | 3-6 pm | " | " | " | 0.62 | 1660 | 108 | 93.5 | 0.72 | 2.15 |
| | 7-10am | " | " | " | 0.52 | 1390 | 84 | 94.0 | 0.72 | 3.01 |
| | 1-4 pm | " | " | " | 0.31 | 820 | 124 | 84.9 | 0.72 | 2.81 |
| | 6-9 pm | " | " | " | 0.67 | 1340 | 148 | 89.0 | 0.72 | 2.09 |
| AVERAGE | | 7.5 | 7.5 | 0.97 | 0.56 | 1445 | 92 | 93.2 | 0.66 | 2.05 |
| 8-31 | 7-10am | 15 | 15 | 1.95 | 0.65 | 870 | 40 | 95.4 | 0.57 | 2.20 |
| | 11-2 pm | " | " | " | 0.56 | 740 | 192 | 74.0 | 0.57 | 1.40 |
| | 3-6 pm | " | " | " | 1.60 | 2130 | 152 | 92.9 | 0.57 | 1.84 |
| | 7-10pm | " | " | " | 2.10 | 2800 | 320 | 88.6 | 0.57 | 1.34 |
| | 11-2 am | " | " | " | 0.85 | 1130 | 98 | 87.0 | 0.57 | 1.75 |
| AVERAGE | | 15 | 15 | 1.95 | 0.73 | 1534 | 176 | 87.7 | 0.57 | 1.71 |
| 9-1 | 7-10am | 20 | 20 | 2.60 | 0.96 | 1040 | 320 | 69.3 | 0.75 | 2.01 |
| | 11-2 pm | " | " | " | 1.47 | 1470 | 400 | 73.0 | 0.96 | 2.53 |
| | 3-6pm | " | " | " | 1.60 | 1650 | 830 | 48.1 | 0.96 | 1.61 |
| | 8-11pm | " | " | " | 1.23 | 1230 | 305 | 75.2 | 1.44 | 1.14 |
| 9-2 | 7-10am | " | " | " | 0.82 | 820 | 288 | 64.9 | 1.62 | 1.20 |
| | 11-2pm | " | " | " | 0.55 | 550 | 110 | 80.0 | 1.53 | 1.45 |
| | 3-6 pm | " | " | " | 1.50 | 1500 | 205 | 86.3 | 1.53 | 1.17 |
| | 7-10pm | " | " | " | 1.25 | 1250 | 110 | 90.0 | 1.44 | 0.94 |
| AVERAGE | | 20 | 20 | 2.60 | 1.17 | 1310 | 343 | 74.0 | 1.28 | 1.51 |

TABLE I (CONT.)

AIR FLOTATION - PEACH RINSE WATER

| 1967 | | Flow - GPM | | Loading | | Suspended Solids | | | Float | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | In | Recycle | GPM/ft$^2$ | lb/hr/ft$^2$ | In | Out | % Rem. | GPM | % Solids |
| 9-5 | 8-11am | 20 | 10 | 1.95 | 0.93 | 930 | 84 | 91.0 | 1.12 | 1.40 |
| | 12-3 pm | " | " | " | 0.80 | 800 | 468 | 41.6 | 1.12 | 2.60 |
| | 4-7 pm | " | " | " | 0.89 | 890 | 148 | 83.4 | 1.12 | 1.90 |
| AVERAGE | | 20 | 10 | 1.95 | 0.88 | 873 | 233 | 72.0 | 1.12 | 2.00 |
| 9-5 | 8-11pm | 30 | 15 | 2.92 | 2.13 | 1420 | 540 | 62.0 | 1.04 | 1.87 |
| 9-6 | 11-2pm | " | " | " | 1.56 | 890 | 275 | 69.0 | 1.21 | 1.66 |
| | 3-6pm | " | " | " | 3.74 | 2490 | 1680 | 32.5 | 1.31 | 1.84 |
| | 12-3am | " | " | " | 1.86 | 1240 | 440 | 64.5 | 1.31 | 2.32 |
| 9-7 | 6-9am | " | " | " | 1.85 | 1230 | 50 | 95.9 | 1.31 | 1.17 |
| | 10-1pm | " | " | " | 1.04 | 690 | 70 | 89.9 | 1.31 | 0.98 |
| | 2-5pm | " | " | " | 3.82 | 2540 | 1220 | 52.0 | 1.31 | 1.20 |
| | 6-9pm | " | " | " | 1.99 | 1320 | 490 | 62.8 | 1.31 | 1.45 |
| AVERAGE | | 30 | 15 | 2.92 | 2.25 | 1480 | 590 | 66.1 | 1.29 | 1.57 |
| 9-27 | 10-8pm | 30 | 10 | 2.60 | 0.44 | 290 | 35 | 87.9 | 0.36 | 2.11 |
| 9-28 | 12-8pm | " | " | " | 0.44 | 280 | 90 | 67.8 | 0.51 | 1.80 |
| 9-29 | 10-5pm | " | " | " | 0.26 | 180 | 84 | 53.3 | 0.26 | 2.43 |
| 9-30 | 11-3pm | " | " | " | 0.24 | 170 | 85 | 50.0 | 0.40 | 2.00 |
| AVERAGE | | 30 | 10 | 2.60 | 0.34 | 228 | 74 | 64.8 | 0.38 | 2.01 |

TABLE II

AIR FLOTATION - TOMATO WASTE WATER

| 1967 | | Flow - GPM | | Loading | | Suspended Solids | | | Float | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | In | Recycle | GPM/ft$^2$ | lb/day/ft$^2$ | In | Out | % Rem. | GPH | % Solids |
| 10-13 | 10-2pm | 7.5 | 7.5 | 0.97 | 7.8 | 870 | 205 | 76.5 | 8.5 | 9.65 |
| | 3-7pm | " | " | " | 15.5 | 1725 | 75 | 95.5 | 8.5 | 10.40 |
| 10-14 | 8-12pm | " | " | " | 10.9 | 1210 | 225 | 81.4 | 4.5 | 6.19 |
| | 1-4pm | " | " | " | 4.5 | 495 | 210 | 59.6 | 4.5 | 6.85 |
| AVERAGE | | 7.5 | 7.5 | 0.97 | 9.7 | 1075 | 179 | 78.3 | 6.5 | 8.27 |
| 10-19 | 12-3pm | 15 | 15 | 1.95 | 9.0 | 500 | 195 | 61.0 | 13.5 | 2.56 |
| | 4-7pm | " | " | " | 15.3 | 850 | 100 | 88.1 | 13.2 | 4.14 |
| 10-20 | 12-4pm | " | " | " | 55.5 | 3060 | 185 | 92.0 | 8.0 | 3.21 |
| | 5-8pm | " | " | " | 14.2 | 790 | 335 | 57.5 | 8.0 | 2.43 |
| 10-21 | 8-12am | " | " | " | 10.7 | 575 | 310 | 46.1 | 12.0 | 2.75 |
| | 1-5pm | " | " | " | 12.3 | 685 | 315 | 54.0 | 12.0 | 2.59 |
| AVERAGE | | 15 | 15 | 1.95 | 19.5 | 1077 | 240 | 66.5 | 11.1 | 2.95 |
| 10-26 | 9-12am | 30 | 15 | 2.92 | 9.75 | 325 | 300 | 7.7 | 3.7 | 2.83 |
| | 1-4 pm | " | " | " | 12.4 | 415 | 220 | 47.0 | 3.7 | 2.59 |
| 10-27 | 10-1 pm | " | " | " | 11.5 | 320 | 115 | 64.1 | 10.9 | 2.46 |
| | 2-6 pm | " | " | " | 40.5 | 1125 | 120 | 93.5 | 10.9 | 2.79 |
| 10-28 | 7-11am | " | " | " | 8.64 | 240 | 205 | 14.6 | 11.7 | 3.87 |
| | 12-3 pm | " | " | " | 12.8 | 355 | 130 | 63.5 | 11.7 | 3.91 |
| AVERAGE | | 30 | 15 | 2.92 | 15.9 | 463 | 182 | 48.4 | 8.8 | 3.08 |

# APPENDIX D

## CENTER DISCHARGE VIBRATING SCREENS FOR SEPARATION OF SOLIDS FROM LIQUID WASTE WATERS

TABLE I

SCREENING OF FRUIT AND TOMATO WASTE WATERS

| Date 1968 | Time | Mesh Top | Mesh Bot. | Percent Screened Top | Percent Screened Bot. | Settleable Solids Two Deck Tyler | Settleable Solids Two Deck Top | Settleable Solids Two Deck Bot. | Settleable Solids Table Top Tyler | Settleable Solids Table Top Eff. | Suspended Solids Two Deck Tyler | Suspended Solids Two Deck Top | Suspended Solids Two Deck Bot. | Suspended Solids Table Top Tyler | Suspended Solids Table Top Eff. | % Moist Two Deck | % Moist Table Top |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/17 | 7-10 am | 64 | 64 | 99 | 1 | 90 | 111 | 95 | * | 74 | * | * | 420 | 370 | 250 | 89.0 | 81.0 |
| 7/17 | 11-2 pm | 64 | 64 | " | " | 68 | 74 | 77 | 71 | 58 | 310 | * | 180 | 160 | 250 | 89.1 | 80.3 |
| 7/18 | 7-10 am | 64 | 64 | " | " | 48 | 49 | 103 | 49 | 59 | 220 | 200 | 630 | 210 | 200 | 80.0 | 80.0 |
| 7/18 | 11-2 pm | 64 | 64 | " | " | 70 | 53 | 65 | 65 | 82 | 170 | 240 | 240 | 270 | 170 | 79.8 | 76.4 |
| 7/19 | 7-10 am | 64 | 64 | " | " | 68 | 69 | 88 | 50 | | 210 | 170 | 260 | 90 | 240 | 79.6 | 77.9 |
| 7/19 | 11-2 pm | 64 | 64 | 98 | 2 | 47 | 55 | 99 | 50 | 43 | 250 | 140 | 430 | 210 | 240 | 78.8 | 79.0 |
| 7/19 | 3-5 pm | 64 | 64 | " | " | 86 | 60 | 201 | 47 | 58 | 300 | 280 | 1200 | 270 | 560 | 77.5 | 77.6 |
| 7/20 | 7-10 am | 64 | 64 | " | " | 67 | 68 | 103 | 53 | 62 | 240 | 110 | 490 | 250 | 390 | 77.8 | 77.0 |
| 7/20 | 11-2 pm | 64 | 64 | " | " | 53 | 49 | 154 | 51 | 50 | 530 | 420 | 770 | 500 | 630 | 77.1 | 77.4 |
| 7/20 | 3-6 pm | 64 | 64 | " | " | 276 | 90 | 709 | 60 | 68 | 450 | 300 | 870 | 540 | 270 | 76.8 | 79.3 |
| 7/22 | 7-10 am | 64 | 64 | 97 | 3 | 59 | 70 | 109 | 55 | 63 | 330 | 80 | 630 | 270 | 380 | 78.4 | 77.0 |
| 7/22 | 11-2 pm | 64 | 64 | 96 | 4 | 68 | 75 | 93 | 63 | 72 | 350 | 210 | 400 | 150 | 270 | 78.9 | 75.8 |
| Ave. | | | | | | 83 | 69 | 167 | 56 | 63 | 305 | 215 | 543 | 274 | 321 | | |
| 7/22 | 7-10 am | 78 | 64 | | | 55 | 52 | 102 | 41 | 60 | 300 | 150 | 550 | 310 | 340 | 79.6 | 76.8 |
| 7/23 | 11-2 pm | 78 | 64 | 70 | 30 | 69 | 70 | 140 | 54 | 52 | 190 | 280 | 490 | 230 | 330 | 80.1 | 77.6 |
| 7/23 | 3-6 pm | 78 | 64 | 70 | 30 | 101 | 89 | 112 | 88 | 79 | 300 | 300 | 380 | 270 | 250 | 78.3 | 77.7 |
| Ave. | | | | | | 75 | 70 | 118 | 61 | 64 | 263 | 243 | 473 | 541 | 307 | | |
| 7/24 | 10-1 pm | 40 | 64 | 98 | 2 | 81 | 57 | 84 | 63 | 59 | 330 | 430 | 520 | 370 | 370 | 77.8 | 78.5 |
| 7/24 | 2-5 pm | 40 | 64 | 90 | 10 | 77 | 75 | 118 | 67 | 84 | 350 | 310 | 850 | 310 | 370 | 80.8 | 78.5 |
| 7/25 | 7-10 am | 40 | 64 | 95 | 5 | 68 | 62 | 112 | 64 | 69 | 490 | 340 | 895 | 400 | 540 | 78.4 | 77.8 |
| 7/25 | 12-2 pm | 40 | 64 | 40 | 60 | 55 | 56 | 70 | 45 | 89 | 380 | 420 | 520 | 260 | 440 | 77.6 | 78.8 |
| 7/25 | 3-6 pm | 40 | 64 | 98 | 2 | 60 | 67 | 136 | 59 | 56 | 380 | 280 | 690 | 380 | 270 | 91.0 | 91.1 |
| 7/26 | 7-10 am | 40 | 64 | 98 | 2 | 71 | 72 | 111 | | 70 | 480 | 440 | 720 | | 490 | 90.0 | 78.7 |
| 7/26 | 11-2 pm | 40 | 64 | 96 | 4 | 64 | 62 | 128 | | 69 | 360 | 370 | 450 | | 450 | 90.6 | 78.3 |
| 7/26 | 3-6 pm | 40 | 64 | | | 68 | 62 | 79 | | 65 | 360 | 360 | 590 | | 270 | 91.0 | 90.7 |
| 7/27 | 7-10 am | 40 | 64 | 97 | 3 | 60 | 66 | 88 | | 57 | 380 | 210 | 520 | | 230 | 93.0 | 91.0 |
| 7/27 | 11-2 pm | 40 | 64 | 97 | 3 | 60 | 61 | 86 | | 71 | 450 | 400 | 490 | | 380 | 90.7 | 91.1 |
| 7/27 | 3-6 pm | 40 | 64 | 98 | 2 | 79 | 114 | 132 | | 64 | 570 | 670 | 580 | | 520 | 93.3 | 91.3 |
| Ave. | | | | | | 68 | 69 | 104 | 59 | 68 | 412 | 385 | 620 | 344 | 394 | | |

TABLE I (CONT.)

SCREENING OF FRUIT AND TOMATO WASTE WATERS

| Date 1968 | Time | Mesh Top | Mesh Bot. | Percent Screened Top | Percent Screened Bot. | Settleable Solids Two Deck Tyler | Settleable Solids Two Deck Top | Settleable Solids Two Deck Bot. | Settleable Solids Table Top Tyler | Settleable Solids Table Top Eff. | Suspended Solids Two Deck Tyler | Suspended Solids Two Deck Top | Suspended Solids Two Deck Bot. | Suspended Solids Table Top Tyler | Suspended Solids Table Top Eff. | % Moist Two Deck | % Moist Table Top |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/30 | 4:30-5:30p | 20 | 64 | 99.9 | 0.1 | 152 | 172 | 440 | | 146 | 440 | 450 | 3400 | | 490 | 91.4 | 92.0 |
| 7/31 | 7-10 am | 20 | 64 | 99.9 | 0.1 | 88 | 110 | 1000 | | 89 | 520 | 590 | 3160 | | 310 | 90.0 | 92.0 |
| 7/31 | 10-2 pm | 20 | 64 | 99.9 | 0.1 | 57 | 68 | 1000 | | 64 | 330 | 440 | 3400 | | 440 | 89.2 | 91.6 |
| 7/31 | 3-6 pm | 20 | 64 | 99.8 | 0.2 | 72 | 81 | 1000 | | 76 | 210 | 320 | 3440 | | 360 | 89.6 | 91.3 |
| 8/1 | 7-10 am | 20 | 64 | 99.8 | 0.2 | 106 | 103 | 704 | | 78 | 370 | 390 | 2320 | | 250 | 90.3 | 92.5 |
| 8/1 | 11-2 pm | 20 | 64 | 99.8 | 0.2 | 66 | 80 | 881 | 66 | 86 | 430 | 500 | 2850 | 430 | 230 | 90.5 | 91.5 |
| 8/1 | 3-6 pm | 20 | 64 | 99.8 | 0.2 | 65 | 71 | 410 | 65 | 78 | 530 | 580 | 3720 | 530 | 590 | 91.0 | 91.5 |
| 8/2 | 7-10 am | 20 | 64 | 99.8 | 0.2 | 75 | 88 | 922 | 75 | 78 | 440 | 580 | 3040 | 440 | 510 | 91.0 | 91.3 |
| 8/2 | 11-2 pm | 20 | 64 | 99.8 | 0.2 | 95 | 102 | 729 | 95 | 98 | 550 | 630 | 3520 | 550 | 660 | 91.3 | 92.0 |
| Ave. | | | | | | 86 | 97 | 787 | 86 | 88 | 424 | 497 | 3205 | 424 | 426 | | |
| 8/3 | 7-10 am | 20 | 78 | 99.98 | 0.02 | 89 | 106 | 430 | 89 | 83 | 220 | 510 | 1560 | 220 | 550 | 91.0 | 93.6 |
| 8/3 | 11-2 pm | 20 | 78 | 99.98 | 0.02 | 76 | 88 | 260 | 76 | 81 | 540 | 580 | 2280 | 540 | 540 | 90.8 | 92.0 |
| 8/5 | 2-5 pm | 20 | 78 | | | 94 | 96 | 381 | 94 | 79 | 360 | 560 | 1760 | 360 | 520 | 89.7 | 92.8 |
| 8/5 | 6-9 pm | 20 | 78 | | | 72 | 76 | 500 | 72 | 88 | 530 | 520 | 2440 | 530 | 550 | 91.4 | 92.2 |
| 8/6 | 7-10 am | 20 | 78 | 99.8 | 0.2 | 71 | 102 | 545 | 71 | 89 | 400 | 490 | 1760 | 400 | 470 | 90.5 | 92.0 |
| 8/6 | 11-2 pm | 20 | 78 | 99.8 | 0.2 | 59 | 73 | 376 | 59 | 70 | 490 | 630 | 840 | 490 | 410 | 90.5 | 93.0 |
| 8/6 | 2-6 pm | 20 | 78 | 99.8 | 0.2 | 71 | 82 | 287 | 71 | 79 | 540 | 660 | 2320 | 540 | 550 | 90.4 | 92.6 |
| Ave. | | | | | | 76 | 89 | 397 | 76 | 80 | 440 | 564 | 1851 | 440 | 512 | | |
| 8/7 | 5-8 pm | 40 | 78 | 99.5 | 0.5 | 92 | 94 | 866 | 92 | 45 | 450 | 480 | 2000 | 450 | 540 | 90.7 | 92.2 |
| 8/8 | 7-10 am | 40 | 78 | 99.5 | 0.5 | 60 | 88 | 670 | 60 | 73 | 500 | 540 | 2160 | 500 | 530 | 90.5 | 91.4 |
| Ave. | | | | | | 76 | 91 | 768 | 76 | 59 | 475 | 510 | 2080 | 475 | 535 | | |
| 8/10 | 7-10 am | 48 | 78 | 99.5 | 0.5 | 60 | 71 | 1000 | 60 | 77 | 390 | 460 | 2560 | 390 | 790 | 90.3 | 92.1 |
| 8/10 | 11-2 pm | 48 | 78 | 99.5 | 0.5 | 68 | 71 | 516 | 68 | 71 | 430 | 290 | 1120 | 430 | 390 | 91.1 | 90.7 |
| 8/10 | 3-6 pm | 48 | 78 | 99.5 | 0.5 | 278 | 667 | | 278 | 209 | 730 | 940 | 5280 | 730 | 810 | 91.9 | 91.9 |
| 8/12 | 11-2 pm | 48 | 78 | 99.5 | 0.5 | 61 | 68 | | 61 | 135 | 440 | 420 | 4560 | 440 | 470 | 91.6 | 91.7 |
| 8/12 | 3-6 pm | 48 | 78 | 99.5 | 0.5 | 62 | 69 | 990 | 62 | 80 | 480 | 380 | 4400 | 480 | 300 | 90.5 | 90.7 |
| 8/12 | 7-10 am | 48 | 78 | 99.5 | 0.5 | 113 | 114 | 913 | 113 | 125 | 730 | 490 | 5000 | 730 | 530 | 89.2 | 90.6 |
| 8/13 | 7-10 am | 48 | 78 | 99.5 | 0.5 | 71 | 142 | 960 | 71 | 76 | 300 | 420 | 4200 | 300 | 330 | 90.7 | 90.7 |
| 8/13 | 11-2 pm | 48 | 78 | 99.5 | 0.5 | 76 | 95 | 975 | 76 | 72 | 470 | 590 | 3360 | 470 | 410 | 90.5 | 91.2 |
| Ave. | | | | | | 99 | 162 | 892 | 99 | 106 | 496 | 499 | 3810 | 497 | 504 | 90.7 | 91.2 |
| 8/14 | 2-5 pm | 64 | 78 | 99.5 | 0.5 | 68 | 66 | 513 | 68 | 70 | 410 | 440 | 2040 | 410 | 490 | 92.7 | 91.9 |

TABLE I (CONT.)

SCREENING OF FRUIT AND TOMATO WASTE WATERS

| Date 1968 | Time | Mesh Top | Mesh Bot. | Percent Screened Top | Percent Screened Bot. | Settleable Solids Two Deck Tyler | Settleable Solids Two Deck Top | Settleable Solids Two Deck Bot. | Settleable Solids Table Top | Suspended Solids Two Deck Tyler | Suspended Solids Two Deck Top | Suspended Solids Two Deck Bot. | Suspended Solids Table Top | % Moisture Two Deck | % Moisture Table Top |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/17 | 1-4 pm | 64 | 94 | 99.0 | 1.0 | 70 | 60 | 175 | 83 | 500 | 500 | 960 | 510 | 91.7 | 89.2 |
| 8/23 | 10-1 pm | 64 | 94 | 99.0 | 1.0 | 120 | 108 | 310 | 145 | 340 | 410 | 1040 | 560 | 90.6 | 91.2 |
| 8/23 | 2-5 pm | 64 | 94 | 99.5 | 0.5 | 97 | 92 | 820 | 128 | 400 | 290 | 1160 | 310 | 92.0 | 90.6 |
| 8/24 | 10:30-1:30p | 64 | 94 | 98.0 | 2.0 | 49 | 76 | 163 | 76 | 460 | 840 | 1160 | 470 | 92.5 | 91.4 |
| 8/24 | 2:30-5:30p | 64 | 94 | 98.0 | 2.0 | 342 | 90 | 618 | 445 | 500 | 430 | 1520 | 640 | 92.1 | 91.2 |
| 8/24 | 6:30-9:30p | 64 | 94 | 98.0 | 2.0 | 74 | 85 | 837 | 79 | 560 | 670 | 1040 | 690 | 89.4 | 89.3 |
| 8/26 | 6-10 pm | 64 | 94 | 98.0 | 2.0 | 81 | 98 | 930 | 118 | 310 | 390 | 2280 | 410 | 90.7 | 90.8 |
| 8/26 | 11-2 pm | 64 | 94 | 98.0 | 2.0 | 78 | 74 | 273 | 51 | 400 | 340 | 1640 | 500 | 91.4 | 89.3 |
| 8/26 | 2-5 pm | 64 | 94 | 98.0 | 2.0 | 75 | 79 | 1000 | 103 | 560 | 490 | 2000 | 500 | 91.2 | 91.4 |
| Ave. | | | | | | 110 | 85 | 570 | 136 | 448 | 410 | 1422 | 510 | 91.3 | 90.5 |
| 8/28 | 7-10 am | 78 | 94 | 97 | 3 | 81 | 58 | 170 | 71 | 410 | 350 | 720 | 520 | 90.4 | 90.6 |
| 8/28 | 11-2 pm | 78 | 94 | 75-98 | 2-25 | 76 | 78 | 146 | 97 | 630 | 570 | 1120 | 700 | 93.4 | 92.3 |
| 8/30 | 7-10 am | 78 | 94 | 75 | 25 | 95 | 70 | 105 | 90 | 350 | 350 | 280 | 320 | 93.8 | 92.0 |
| 8/30 | 11-2 pm | 78 | 94 | 75 | 25 | 73 | 67 | 156 | 81 | 510 | 510 | 1200 | 650 | 92.5 | 90.3 |
| Ave. | | | | | | 81 | 68 | 144 | 85 | 475 | 445 | 830 | 547 | 92.5 | 91.3 |
| 9/3 | 8-11 am | 80 | 100 | 60-90 | 10-40 | 65 | 66 | 100 | 79 | 290 | 250 | 360 | 340 | 92.6 | 90.6 |
| 9/3 | 12-3:30p | 80 | 100 | 50-99 | 1-50 | 80 | 80 | 105 | 70 | 340 | 290 | 560 | 250 | 92.5 | 90.5 |
| 9/4 | 6-9 am | 80 | 100 | 90 | 10 | 116 | 109 | 181 | 95 | 440 | 310 | 360 | 380 | 92.4 | 92.1 |
| 9/4 | 10-1 pm | 80 | 100 | 90 | 10 | 71 | 78 | 319 | 76 | 460 | 410 | 880 | 480 | 93.4 | 92.7 |
| 9/5 | 8-11 am | 80 | 100 | 90 | 10 | 73 | 68 | 179 | 79 | 370 | 320 | 800 | 340 | 91.9 | 92.1 |
| 9/5 | 12-3 pm | 80 | 100 | 90 | 10 | 53 | 55 | 81 | 88 | 480 | 360 | 640 | 470 | 93.3 | 92.1 |
| 9/6 | 8-11 am | 80 | 100 | 70-90 | 10-30 | 86 | 86 | 193 | 77 | 380 | 380 | 880 | 380 | 93.6 | 92.2 |
| Ave. | | | | | | 78 | 77 | 165 | 81 | 394 | 331 | 640 | 377 | 92.8 | 91.8 |
| 9/7 | 7-10 am | 100 | 100 | 60 | 40 | 60 | 55 | 95 | 60 | 360 | 300 | 600 | 310 | 93.3 | 91.6 |
| 9/7 | 11-2 pm | 100 | 100 | 60 | 40 | 59 | 66 | 108 | 78 | 420 | 530 | 440 | 470 | 94.7 | 90.8 |
| 9/9 | 8-11 am | 100 | 100 | 70 | 30 | 118 | 128 | 148 | 152 | 580 | 370 | 520 | 480 | 95.1 | 93.1 |
| 9/9 | 12-3 pm | 100 | 100 | 60 | 40 | 48 | 43 | 68 | 63 | 300 | 230 | 360 | 320 | 95.1 | 90.4 |
| 9/10 | 8-11 pm | 100 | 100 | 60 | 40 | 88 | 91 | 99 | 73 | 310 | 190 | 340 | 210 | 95.5 | 91.4 |
| 9/10 | 12-3 pm | 100 | 100 | 90 | 10 | 60 | 52 | 130 | 73 | 390 | 310 | 540 | 340 | 93.0 | 91.8 |
| 9/12 | 2-4 pm | 100 | 100 | 70 | 30 | 55 | 41 | 108 | 59 | 220 | 190 | 340 | 370 | 91.7 | 90.6 |
| 9/13 | 6-9 pm | 100 | 100 | 95 | 5 | 73 | 65 | 182 | 71 | 260 | 270 | 320 | 290 | 93.1 | 91.6 |
| 9/13 | 10-1 pm | 100 | 100 | 95 | 5 | 92 | 88 | 184 | 60 | 490 | 430 | 820 | 370 | 93.9 | 93.6 |

TABLE I (CONT.)

SCREENING OF FRUIT AND TOMATO WASTE WATERS

| Date 1968 | Time | Mesh Top | Mesh Bot. | Percent Screened Top | Percent Screened Bot. | Settleable Solids Two Deck Tyler | Settleable Solids Two Deck Top | Settleable Solids Two Deck Bot. | Settleable Solids Table Top | Suspended Solids Two Deck Tyler | Suspended Solids Two Deck Top | Suspended Solids Two Deck Bot. | Suspended Solids Table Top | % Moisture Two Deck | % Moisture Table Top |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/14 | 7-10 am | 100 | 100 | 95 | 5 | 63 | 57 | 135 | 59 | 400 | 380 | 440 | 330 | 92.4 | 91.0 |
| 9/14 | 11-2 pm | 100 | 100 | 95 | 5 | 54 | 45 | 100 | 56 | 510 | 450 | 800 | 460 | 92.6 | 92.2 |
| 9/16 | 9/12 am | 100 | 100 | 80 | 20 | 65 | 51 | 130 | 71 | 290 | 240 | 460 | 300 | 93.3 | 91.1 |
| 9/16 | 1-4 pm | 100 | 100 | 90 | 10 | 83 | 56 | 111 | 65 | 390 | 260 | 400 | 370 | 92.1 | 91.0 |
| 9/17 | 8-11 am | 100 | 100 | 90 | 10 | 47 | 43 | 173 | 57 | 380 | 490 | 500 | 440 | 92.6 | 91.7 |
| 9/17 | 12-3 pm | 100 | 100 | 90 | 10 | 28 | 29 | 72 | 44 | 680 | 870 | 740 | 810 | 92.3 | 91.5 |
| 9/18 | 8-11 am | 100 | 100 | 95 | 5 | 53 | 45 | 100 | 47 | 620 | 560 | 720 | 610 | 92.0 | 91.4 |
| 9/18 | 1-4 pm | 100 | 100 | 95 | 5 | 86 | 52 | 93 | 65 | 660 | 520 | 840 | 610 | 92.8 | 89.8 |
| 9/19 | 8-11 am | 100 | 100 | 95 | 5 | 109 | 80 | 212 | 79 | 500 | 430 | 780 | 650 | 93.9 | 91.9 |
| 9/19 | 1-3 pm | 100 | 100 | 95 | 5 | 63 | 50 | 89 | 53 | 520 | 480 | 420 | 650 | 92.0 | 89.8 |
| 9/20 | 6-9 am | 100 | 100 | 95 | 5 | 75 | 52 | 190 | 57 | 570 | 370 | 620 | 340 | 92.0 | 90.6 |
| Ave. | | | | | | 69 | 59 | 126 | 67 | 443 | 394 | 550 | 437 | 93.2 | 91.3 |
| 9/23 | 1:30-4:30p | 100 | 78 | 40 | 60 | 47 | 37 | 78 | 58 | 430 | 370 | 420 | 370 | 93.0 | 92.0 |
| 9/24 | 1:30-4:30p | 100 | 78 | 50 | 50 | 64 | 45 | 76 | 51 | 460 | 450 | 540 | 520 | 93.6 | 92.4 |
| 9/26 | 1:30-4:30p | 100 | 78 | 60 | 40 | 50 | 37 | 83 | 33 | 980 | 960 | 1040 | 950 | 93.3 | 92.6 |
| Ave. | | | | | | 54 | 40 | 79 | 47 | 623 | 593 | 667 | 613 | 93.3 | 92.3 |
| 9/28 | 8-11 am | 80 | 78 | 90 | 10 | 107 | 100 | 201 | 98 | 790 | 660 | 740 | 750 | 92.0 | 92.4 |
| 9/28 | 12-3 pm | 80 | 78 | 90 | 10 | 79 | 59 | 145 | 63 | 740 | 600 | 940 | 710 | 92.5 | 90.0 |
| 9/28 | 4-7 pm | 80 | 78 | 90 | 10 | 134 | 100 | 187 | 95 | 680 | 570 | 640 | 610 | 93.7 | 91.6 |
| 9/30 | 1:30-4:30p | 80 | 78 | 85 | 15 | 72 | 62 | 159 | 58 | 330 | 340 | 520 | 390 | 92.8 | 90.9 |
| 10/2 | 3-6 pm | 80 | 78 | 50-60 | 40-50 | 56 | 50 | 71 | 59 | 530 | 490 | 560 | 500 | 93.9 | 92.3 |
| 10-3 | 12:30-3:30p | 80 | 78 | 75 | 25 | 55 | 38 | 90 | 39 | 410 | 480 | 400 | 400 | 92.4 | 92.0 |
| Ave. | | | | | | 84 | 68 | 142 | 69 | 585 | 512 | 647 | 560 | 92.9 | 91.5 |
| 10/5 | 8-11 am | 64 | 78 | 92-95 | 5-8 | 43 | 42 | 163 | 40 | 370 | 320 | 660 | 370 | 91.8 | 92.3 |
| 10/5 | 4:30-7:30a | 64 | 78 | 92-95 | 5-8 | 34 | 33 | 99 | 33 | 510 | 450 | 560 | 530 | 91.5 | 89.6 |
| 10/5 | 2-5 pm | 64 | 78 | 80-85 | 10-15 | 64 | 69 | 159 | 52 | 380 | 440 | 480 | 480 | 92.2 | 92.2 |
| 10/7 | 3-6 pm | 64 | 78 | 95-99 | 1-5 | 72 | 72 | 200 | 62 | 340 | 320 | 700 | 270 | 91.2 | 91.0 |
| 10/8 | 12-3 pm | 64 | 78 | 90-95 | 5-10 | 58 | 48 | 138 | 54 | 220 | 280 | 380 | 280 | 91.3 | 91.4 |
| 10/9 | 2-5 pm | 64 | 78 | 92-99 | 1-8 | 59 | 51 | 114 | 54 | 410 | 410 | 580 | 420 | 91.7 | 92.1 |
| 10/10 | 2-5 pm | 64 | 78 | 95 | 5 | 53 | 48 | 112 | 55 | 500 | 410 | 660 | 470 | 92.5 | |
| Ave. | | | | | | 55 | 52 | 141 | 50 | 390 | 377 | 569 | 403 | 91.7 | 91.4 |

| 1 Accession Number | 2 Subject Field & Group | SELECTED WATER RESOURCES ABSTRACTS<br>INPUT TRANSACTION FORM |
|---|---|---|
| | Ø5D | |

5 Organization
National Canners Association
1950 Sixth Street
Berkeley, California 94710

6 Title
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10 Author(s)
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Walter W. Rose

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23 Descriptors (Staired First)

*Canneries, *Industrial Wastes, *Disinfection, *Screens, *Trickling Filters, *Separation Techniques, Water Pollution

25 Identifiers (Starred First)

*pH Control, *Peach Wastes, Tomato Wastes

27 Abstract

Trickling Filter--The effects of hydraulic loading and nutrient addition on soluble B.O.D. removal from fruit waste water were investigated. In 1968, at 1250 gpd/sq ft without nutrient addition, 190 lbs of B.O.D./1000 cu ft/day were removed; with nutrient (anhydrous ammonia) addition, 450 lbs of B.O.D. were removed. At 2200 gpd/sq ft, B.O.D. removal decreased slightly.

pH Control - Fruit pumping water was acidified with citric acid and controlled at pH 4.0 or below to inhibit bacterial growth and to extend the use of recirculated water. The daily discharge volume of acidified system was 6720 gallons containing 118 lbs of B.O.D.; non-acidified, 26,520 gallons, 170 lbs B.O.D.

Air Flotation System -Removal from peach rinse water was 65 to 93 percent at 2700 gpd/sq ft and 1400 gpd/sq ft respectively. A 70 percent removal was maintained at 2300 gpd/sq ft for peach and 1400 gpd/sq ft for tomato waste water.

Screens- The maximum capacity of the single (20 mesh) deck was 1000 gpm. Compared to 20 mesh rectangular screen, 48 mesh removed 32.2 percent more solids. For the double deck unit containing a 20 mesh top and 100 mesh bottom, the unit handled 1500 gpm - 1.5 times the single deck unit.

Abstractor Walter W. Rose | Institution National Canners Association

WR:102 (REV JULY 1969)
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